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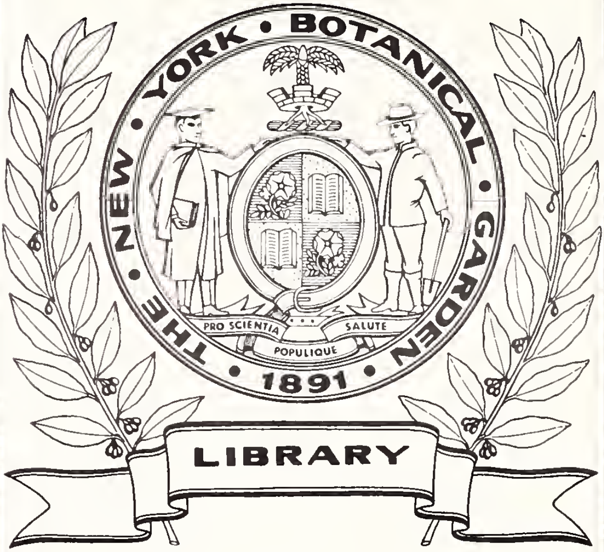

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ARNOLD ARBORETUM
HARVARD UNIVERSITY

ARNOLDIA

A continuation of the
Bulletin of Popular Information

VOLUME XXVII
1967

PUBLISHED BY THE
ARNOLD ARBORETUM
JAMAICA PLAIN, MASSACHUSETTS

12612 .K30
vol. 27 nos. 1-2
cop. 2

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JUN 26 1967
NEW YORK
BOTANICAL GARDEN

ARNOLDIA

A continuation of the
BULLETIN OF POPULAR INFORMATION
of the Arnold Arboretum, Harvard University

VOLUME 27 MARCH 24, 1967 NUMBERS 1–2

SEASONAL RHYTHM OF DEVELOPMENT OF WOODY PLANTS AND ITS IMPORTANCE IN INTRODUCTION[1]

THE most important obstacle to introduction of a wide variety of forest and ornamental trees and shrubs in temperate climates has been the poor winter-hardiness of many species. At present, the collections of the Main Botanical Gardens in Moscow include more than 2330 kinds of trees and shrubs. These represent 247 genera and 70 plant families. Of these, only about 51% have shown good winter-hardiness; the rest have suffered some degree of injury. Therefore, one of the principal objectives of our experimental work is to determine which plants are winter resistant and the best ways of increasing the hardiness of the others.

Winter and frost resistance of woody plants is a complicated phenomenon. It depends upon the ecological characteristics of a species, variety or biotype; it varies within populations and it changes considerably during the development of the individual plant with age and during the yearly seasonal developmental cycle. Moreover, the seasonal variation in frost resistance within a single woody plant is often greater than the differences in frost resistance among plants of different species. For example, Prof. I. Tumanov[2] has found that plants of *Betula pubescens* are damaged by temperatures lower than 23° F. while in active growth, but after complete winter hardening they can withstand −319° F. in test chambers for long periods of time.

These data suggest the value of investigating the seasonal development of hardiness in woody plants. Such investigations would help to solve the problem of acclimatizing these plants and increasing their frost resistance.

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[1] This paper was presented by the author at the XVII International Horticultural Congress, August 15–20, 1966, at the University of Maryland, College Park, Maryland, under the title "Seasonal Rhythm of the Development of Arboreal Plants and its Importance for Introduction".

[2] Member of Correspondence, Institute of Plant Physiology, Russian Academy of Sciences, Moscow. Prof. Tumanov has been an internationally recognized researcher in the field of frost hardiness for many years.

In the development of woody plants, changes with age and seasonal changes occur in combination. The latter are repeated rhythmically year after year during the lifetime of the plant. Changes in seasonal development appeared during the process of evolution, as plants adapted themselves to sharp climatic changes occurring over most of the world.

In most cases, frost resistance of woody plants also increases with age, from the juvenile stage to maturity. This increase is seen as a trend over the years, during which the rhythmical seasonal changes described earlier are also occurring.

Most investigators distinguish four important periods in the yearly cycle of development of woody plants: shoot growth, differentiation of organs, internal dormancy or rest, and environmentally induced dormancy.

A strict seasonal rhythm is observed in the change of these periods. This rhythm is a specific property of the species and is controlled by the internal system of self-regulation of the organism. This system, in turn, is regulated by the signals of rhythmically changing environmental factors, such as length of day, air temperature, and soil moisture. So the rhythm of seasonal development may to a certain degree depend upon the weather of the current and previous year. Research data show that seasonal rhythms are found in all principal phases of morphogenesis and in all physiological, biochemical and biophysical processes of metabolism.

In the seasonal rhythm of development, frost resistance of woody plants is sharply increased when growth and differentiation of organs are completed, before the period of internal dormancy. According to Prof. I. Tumanov's findings, this increase in frost resistance is accomplished in three stages: entry into the period of dormancy, phase I of hardening, with low temperatures above freezing, and phase II of hardening, with temperatures below freezing.

Changes that take place during hardening include accumulation of protective substances (sugar), formation of growth inhibitors, change in the submicroscopic structure of protoplasm, change in the cell water supply resulting in the formation of ice only in the intercellular spaces, and increase in the permeability of the protoplasm and its resistance to desiccation.

Modern physiological findings on the nature of frost resistance suggest that successful introduction and acclimatization of woody plants can be achieved partly by selecting forms having favorable rhythms of seasonal development, and partly through the use of different methods of regulation of these rhythms. We have used these approaches in studying the large collection of introduced trees and shrubs gathered at the Dendrology Department of the Main Botanical Gardens.

A large number of species, represented by many specimens of different origins, can be studied only by the method of elementary analysis of the initial material to find species, forms and individuals with favorable rhythms of seasonal development. Considering this, comparative study of data from very thorough phenological observations proved quite valuable.

Study of Species of the Japanese-Chinese Subregion

The method described was tested at the Dendrology Department by analyzing plants from different botanical-geographic regions, to reveal resistant species within genera and to determine the extent of variations within species.

For example, the method was used to analyze plants of our collection introduced from the Japanese-Chinese subregion. These plants are of various floral types and differ considerably in their seasonal rhythms of growth and development.

Plants of 323 species, botanically verified, were chosen for investigation. They are listed at the end of this paper. These plants were divided into four groups depending on the time of beginning and end of annual vegetative growth:

Group EE – 133 species with early beginning and early end of growth (147 to 160 days from bud swelling to general defoliation).
Group EL – 147 species with early beginning and late end of growth (168 to 183 days from bud swelling to general defoliation).
Group LE – 14 species with late beginning and early end of growth (130 to 150 days from bud swelling to general defoliation).
Group LL – 29 species with late beginning and late end of growth (157 to 176 days from bud swelling to general defoliation).

Species stated as starting growth early showed marked bud swelling before April 27, and shoots started to grow between May 1 and May 20. Species stated as ending growth early stopped growing between July 1 and July 10 and began to defoliate generally before October 3. Late start and late end of growth are then designated as when these phases occur later than the times stated. Plants whose shoot development is stopped by low temperatures were usually included in the latter category.

Plants belonging to these four groups have essential differences in winter hardiness (Table I).

Plants of Group EE are very winter hardy under Moscow conditions. Most of the plants native to the subtropical subregions fall into Group EL and are less winter hardy. In Group LE, winter hardiness of the plants was higher with late but natural finishing of growth than when shoot growth was stopped by low temperatures. An overwhelming majority of the plants in Group LL have very poor winter hardiness. Seventy-three percent of the plants in Group EE and only 3% of plants in Group LL were fully winter hardy.

If a plant passes through the whole developmental cycle, it can be adapted successfully. Although some of the tested plants have not yet reached maturity, 67% of them bear fruit. This is certainly enough to compare data of flowering and fruit bearing in plants of different phenological groups (Table II). Data in

Table I

WINTER-HARDINESS OF PLANTS OF VARIOUS PHENOLOGICAL GROUPS

Phenological Groups	Species Total		Categories of Winter Hardiness I		II		III		IV		V		VI		VII	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
EE	133	41	97	73	31	23	2	1.5	2	1.5	—	—	1	1	—	—
EL	147	45	56	38	66	45	5	3	9	6	4	3	6	4	1	1
LE	14	5	4	28	4	28	1	8	1	8	—	—	4	28	—	—
LL	29	9	1	3	5	18	2	7	1	3	3	10	14	49	3	10
In all groups	323	100	158	49	106	33	10	3	13	4	7	2	25	8	4	1

I	Plants not damaged by frost.
II	Not more than 50% of a summer shoot damaged.
III	More than 50% of a summer shoot damaged.
IV	Some damage to more mature shoots.
V	Damage to shoots above snow.
VI	The whole above-ground part of the plant damaged.
VII	The whole plant destroyed.

this table are very significant. Most of the species in Group EE (78%) pass through the whole developmental cycle in Moscow, while only 17% of the plants in Group LL do so.

There are several reasons for the ability or failure of species in the different groups to flower and bear fruit. In Group EE, plants failing to fruit are mostly young and immature, but some are of dioecious species with no female specimens present. Four or five of the fruit-bearing species in Group LL are subshrubs wintering under snow. Flowering species fail to bear fruit when flowers or young fruit are damaged by frost.

The example cited shows that this method of selection, with proper study of phenological data, makes it possible to foresee differences in rhythms of growth processes, to make preliminary evaluation of introduced plants in a short time, and to group plants according to differences in growth, development, winter hardiness, and other biological characters that help to predict the possibilities of introducing these plants.

Study of Species of Soviet Middle Asia

The same method of investigation was used to analyze 95 woody plant species of Soviet Middle Asia. Ninety-four percent of the plants in Group EE were fully winter hardy or only slightly damaged by frost and 94% bore fruit regularly. Plants in Group LL were damaged by frost more or less severely.

This same method was used to study a complex of introduced species of *Lonicera* and intraspecies groups of *Quercus robur*, in both cases with effective results.

This method allows only preliminary evaluation of plant species. As mentioned earlier, winter hardiness and frost resistance are among the most complicated phenomena in plants. They depend on so many factors that it is sometimes very

TABLE II

DISTRIBUTION OF FRUIT-BEARING, ONLY FLOWERING AND NON-FLOWERING SPECIES IN PHENOLOGICAL GROUPS

Phenological Group	Total No.	Fruit-bearing No.	%	Only flowering No.	%	Non-flowering No.	%
EE	133	103	78	8	6	22	16
EL	147	101	68	20	14	26	18
LE	14	6	43	3	21	5	36
LL	29	5	17	9	31	15	52
All groups	323	215	67	40	12	68	21

difficult to take them all into account. But the simplicity and value of this method are enough to repay the effort of making observations and analyzing data.

From these data it is possible to conclude that woody plants with a relatively early beginning and end of growth have the most favorable type of seasonal development for introduction into the temperate climate of the European part of the USSR, and very likely in any other area experiencing similar temperatures.

By this method, resistant forms and ecotypes within species can be selected according to the duration of the growth period, and winter-hardiness of species within genera can be predicted. The method also can be applied for evaluation of plants available for introduction from various botanical and geographic regions.

Modification of Winter Hardiness

These results point out the directions that future investigations to increase the frost resistance of introduced plants should take. Through application of physiologically active substances, modification of photoperiod, and various agrotechnics, experiments should be conducted to stimulate growth processes in spring and to inhibit shoot growth in late summer. This would allow normal lignification of tissues, formation of buds, differentiation of bud organs, and entry into internal dormancy at the beginning of autumn, and hardening of plants could then follow. Application of gibberellin in spring and inhibitors and defoliants in late summer have been reported to be useful for this purpose.

Agrotechnical methods designed for shifting vegetative growth to earlier dates were tested in the Dendrology Department of the Main Botanical Gardens. When complete mineral fertilizer (containing nitrogen, phosphorus, and potassium) was added to the soil in which seedlings of *Morus alba* were growing, growth was quickened considerably and subsequent lignification of shoots was increased sevenfold.

In experiments on the effects of different fertilizers on growth of 2 year old woody seedlings, we have found that the quality of root nutrition influences both the amount of growth made and the time when it occurs. Various combinations of fertilizers were used. In certain cases, vegetative growth occurred earlier as a result of treatment. Results of one such experiment are given in Table III. Fertilization, especially a combination of mineral fertilizers and farmyard manure, favorably influenced the time of growth of the seedlings. Growth was stimulated and completed at earlier dates, thus favoring hardening to withstand winter.

Using plants from warm regions, we studied the influence of different fertilizers added to the soil in combination with foliar applications containing phosphorus, potassium, copper, and boron, as well as a short-day treatment, upon growth and ability to stand winter.

Short-day treatment during the second half of summer, in combination with organic and mineral fertilizers, has resulted in greater winter hardiness. The heights of healthy stems of *Robinia pseudoacacia*, *Catalpa bignonioides*, and *Ailan-*

TABLE III

EFFECT OF FERTILIZATION ON TIME OF GROWTH OF SEEDLINGS OF THREE SPECIES

Percentage of annual height growth occurring before July 20

Fertilizer	Fraxinus pennsylvanica	Ulmus laevis	Larix sibirica
Podzolic soil without added fertilizer	72	49	52
Lime—5 tons* per acre Peat – 60 tons* per acre Mineral fertilizer: Nitrogen—44 lbs. per acre Phosphorus—132 lbs. per acre Potassium—66 lbs. per acre	94	89	65
Lime—5 tons* per acre Farmyard manure – 60 tons* per acre Mineral fertilizer: Nitrogen—44 lbs. per acre Phosphorus—132 lbs. per acre Potassium—66 lbs. per acre	—	96	70

* Metric tons. One metric ton equals 2204.6 lbs.

thus altissima after winter were, respectively, 77%, 87%, and 333% greater than those of untreated seedlings.

We have already obtained positive results in our detailed investigations of intraspecific diversity of woody plants in our collection, and in selection and introduction of resistant forms.

Until now we have been able to induce fruiting and to germinate seeds of 726 species of trees and shrubs. Included in these are many plants from areas of warm climate, such as *Catalpa bignonioides*, *C. speciosa*, *Carpinus betulus*, *Chaenomeles japonica*, *C. maulei*, *Paeonia*, *Cotoneaster horizontalis*, *Lonicera periclymenum* var. *belgica*, *Taxus baccata*, and others. Plants that have already borne fruit include *Pyracantha coccinea*, *Mespilus germanica*, *Laburnum anagyroides*, *Cornus mas*, *Hamamelis virginiana*, *Taxus canadensis*, and others.

Selecting woody plants on the basis of their rhythms of seasonal development, in combination with other methods, in the future will help to solve problems of introduction and acclimatization of plants.

List of Plants
Introduced from the Japanese-Chinese Botanical, Geographic Subregion in the Main Botanical Gardens in Moscow

(Summarized in Tables I and II)

*Name**	*Pheno-logical Group*	*Winter Hardiness Category*	*Fruiting (Fr) or Flowering (Fl)*
Abelia coreana Nakai	EE	I	Fr
Acanthopanax sessiliflorus (Rupr. et Maxim.) Seem.	EE	I	Fr
Acer barbinerve Maxim.	EE	I	Fr
Acer ginnala Maxim.	EE	I	Fr
Acer komarovii Pojark.	EL	II	—
Acer mandshuricum Maxim.	EE	I	—
Acer miyabei Maxim.	EE	I	—
Acer mono Maxim.	EE	I	Fr
Acer palmatum Thunb.	EL	IV	—
Acer pictum Thunb.	EE	I	—
Acer pseudosieboldianum (Pax.) Kom.	EL	I	—
Acer sieboldianum Miq.	EL	IV	—
Acer tegmentosum Maxim.	EE	I	Fr
Acer ukurunduense Trautv. et Mey.	EL	II	Fr
Actinidia arguta (Sieb. et Zucc.) Planch.	EL	II	—
Actinidia giraldii Diels	EL	II	Fl
Actinidia kolomikta (Rupr.) Maxim.	EE	II	Fr
Actinidia polygama (Sieb. et Zucc.) Maxim.	LL	III	Fl
Ailanthus altissima (Mill.) Swingle	LE	IV	—
Alnus fruticosa Rupr.	EE	I	Fr
Alnus hirsuta Turcz.	EL	I	—
Alnus japonica Sieb. et Zucc.	EL	I	—
Ampelopsis aconitifolia Bge.	EE	IV	Fr
Ampelopsis brevipedunculata (Maxim.) Trautv.	LE	III	Fr
Ampelopsis japonica (Thunb.) Makino	LE	VI	Fr
Aralia chinensis L.	EL	VI	Fr
Aralia mandshurica Rupr. et Maxim.	EE	I	Fr
Aristolochia manshuriensis Kom.	EE	II	—
(Prunus) Armeniaca manshurica (Maxim.) Skvortz.	EL	II	Fr
(Prunus) Armeniaca sibirica (L.) Lam.	EE	II	Fl
(Prunus) Armeniaca vulgaris Lam.	EE	II	Fr
Artemisia gmelini Web.	EL	IV	Fl
Artemisia lagocephala (Bess.) DC.	EL	IV	Fl
(Clematis) Atragene ochotensis Pall.	EE	IV	Fr

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* [Names given are those in current use in the Soviet Union, and do not necessarily agree with those in Rehder's *Manual of Cultivated Trees and Shrubs.* For the convenience of readers accustomed to the latter treatment, where generic names differ, the name accepted by Rehder (in parentheses) precedes the generic name used here. This should not be construed to mean that the parenthetical generic name can simply be inserted into the binomial as it stands. To find the equivalent binomial accepted by Rehder, refer the full binomial given to Rehder's *Bibliography of Cultivated Trees and Shrubs.*—EDITOR.]

Berberis amurensis Rupr.	EL	II	Fr
Berberis coreana Palib.	EL	II	Fr
Berberis poiretii C.K.Schneid.	EL	II	Fr
Berberis sieboldii Miq.	EL	II	—
Berberis thunbergii DC.	EL	II	Fr
Betula albo-sinensis Burk.	EE	I	—
Betula costata Trautv.	EE	I	—
Betula davurica Pall.	EE	I	Fr
Betula ermani Cham.	EL	I	Fr
Betula grossa Sieb. et Zucc.	EL	II	—
Betula japonica Sieb.	EE	I	Fr
Betula mandshurica (Rgl.) Nakai	EL	I	Fr
Betula middendorffi Trautv. et Mey.	EE	I	Fr
Betula ovalifolia Rupr.	EE	I	Fr
Betula platyphylla Sukacz.	EE	I	Fr
Betula schmidtii Rgl.	EL	II	Fl
Betula tauschii Koidz.	EL	I	Fl
Betula ulmifolia Sieb. et Zucc.	EL	I	Fr
Broussonetia papyrifera (L.) L'Herit	LE	VI	—
Buddleia albiflora Hemsl.	LL	VI	Fl
Buddleia davidi Franch.	LL	VI	Fl
Buddleia japonica Hemsl.	LL	VI	Fl
Callicarpa bodinieri Lévl. v. giraldii Rehd.	LE	VI	—
Callicarpa japonica Thunb.	LE	VI	Fl
Caragana boisii C.K.Schneid.	EL	I	Fr
Caragana fruticosa (Pall.) Bess.	EL	I	Fr
Caragana microphylla (Pall.) Lam.	EL	I	Fr
Caragana ussuriensis (Rgl.) Pojark.	EL	II	—
Carpinus cordata Blume	EL	I	—
Carpinus erosa Blume	EL	I	—
Catalpa ovata G.Don.	LE	II	Fl
Celastrus flagellaris Rupr.	EL	II	Fr
Celastrus orbiculata Thunb.	EL	II	Fr
(Prunus) Cerasus glandulosa (Thunb.) Lois.	EL	II	Fr
(Prunus) Cerasus japonica (Thunb.) Lois.	EE	II	Fr
(Prunus) Cerasus tomentosa (Thunb.) Wall.	EE	II	Fr
Cercidiphyllum japonicum Sieb. et Zucc.	EL	II	Fl
Chaenomeles cathayensis (Hemsl.) C.K.Schneid.	EL	II	Fr
Chaenomeles japonica (Thunb.) Lindl.	EL	II	Fr
Chaenomeles maulei (Mast.) C.K.Schneid.	EL	II	Fr
Chosenia macrolepis (Turcz.) Kom.	EE	II	Fl
Clematis brevicaudata DC.	LL	VI	Fl
Clematis fusca Turcz.	LL	VI	Fr
Clematis heracleifolia DC.	LL	VI	Fl
Clematis mandshurica Rupr.	LL	VI	Fr
Clematis paniculata Thunb.	LL	VI	Fr
Clematis serratifolia Rehd.	LL	VI	Fr
Cornus alba L.	EL	I	Fr
Corylopsis spicata Sieb. et Zucc.	LL	II	Fl
Corylus heterophylla Fisch.	EE	I	Fr

Corylus mandshurica Maxim.	EE	I	Fr
Corylus sieboldiana Blume	EL	I	—
Cotoneaster acutifolia Turcz.	EL	I	Fr
Cotoneaster bullata Bois.	EL	V	Fr
Cotoneaster dielsiana Pritz.	EL	V	Fr
Cotoneaster divaricata Rehd. et Wils.	EL	V	Fr
Cotoneaster foveolata Rehd. et Wils.	EL	II	Fr
Cotoneaster horizontalis Dcne.	EL	IV	Fr
Cotoneaster melanocarpa Lodd.	EE	I	Fr
Cotoneaster moupinensis Franch.	EL	II	Fr
Cotoneaster multiflora Bge.	EE	I	Fr
Cotoneaster nitens Rehd. et Wils.	EL	IV	—
Cotoneaster obscura Rehd. et Wils.	EL	III	Fr
Cotoneaster zabelii C.K.Schneid.	EL	IV	Fr
Crataegus chlorosarca Maxim.	EE	I	Fr
Crataegus dahurica Koehne	EE	I	Fr
Crataegus maximowiczii C.K.Schneid.	EE	I	Fr
Crataegus pinnatifida Bge.	EE	I	Fr
(Potentilla) Dasiphora davurica (Nestl.) Kom. et Klob.-Alis.	EE	II	Fr
(Potentilla) Dasiphora fruticosa (L.) Rydb.	EL	II	Fr
(Potentilla) Dasiphora mandshurica (Maxim.) Juz.	EL	II	Fr
Deutzia amurensis (Rgl.) Airy-Shaw.	EE	II	Fr
Deutzia glabrata Kom.	EE	II	Fr
Deutzia gracilis Sieb. et Zucc.	EL	II	Fr
Deutzia scabra Thunb. f. plena (Maxim.) Rehd.	LL	V	Fl
(Oplopanax) Echinopanax elatum Nakai	EE	I	Fr
Elaeagnus umbellata Thunb.	EE	III	Fl
(Acanthopanax) Eleutherococcus senticosus (Rupr. et Maxim.) Maxim.	EE	I	Fr
Eucommia ulmoides Oliv.	EL	VI	—
Euonymus bungeana Maxim.	EL	II	Fr
Euonymus maackii Rupr.	EE	I	Fr
Euonymus macroptera Rupr.	EE	I	Fr
Euonymus maximowicziana (Prokh.) Schuch.	EE	I	—
Euonymus pauciflora Maxim.	EE	I	Fr
Euonymus sachalinensis (Fr. Schmidt) Maxim.	EE	I	Fr
Euonymus sacrosancta Koidz.	EE	I	Fr
Euonymus sieboldiana Blume	EE	I	Fr
Euonymus yedoensis Koehne	EE	I	Fr
Exochorda giraldii Hess.	EL	II	Fr
Fontanesia fortunei Carr.	LL	III	—
Forsythia ovata Nakai	EL	I	Fl
Forsythia suspensa (Thunb.) Vahl.	EL	III	Fl
Forsythia viridissima Lindl.	EL	VI	—
Fraxinus mandshurica Rupr.	LE	I	Fr
Fraxinus mariesii Hook.f.	LL	VI	—
Fraxinus rhynchophylla Hance	LE	I	—
(Ribes) Grossularia burejensis (Fr. Schmidt) Berger	EE	II	Fr
Hamamelis japonica Sieb. et Zucc.	LL	II	Fl
Hamamelis mollis Oliv.	LL	V	—

Hydrangea bretschneideri Dipp.	EE	II	Fr
Hydrangea paniculata Sieb.	EL	II	Fl
Hydrangea serrata (Thunb.) DC.	EL	II	Fl
Juglans cordiformis Maxim.	LE	I	Fl
Juglans mandshurica Maxim.	EE	I	Fr
Juglans sieboldiana Maxim.	LE	I	—
Kalopanax septemlobum (Thunb.) Koidz.	EE	I	—
Kerria japonica (L.) DC.	EL	IV	Fl
Kolkwitzia amabilis Graebn.	EL	III	Fl
Ledum macrophyllum Tolm.	EL	I	Fr
Lespedeza bicolor Turcz.	LL	VI	Fr
(Syringa) Ligustrina amurensis Rupr.	EE	I	Fr
Ligustrum ciliatum Sieb.	EL	II	Fr
Ligustrum ibota Sieb.	EL	II	Fr
Ligustrum ovalifolium Hassk.	EL	VII	—
Ligustrum sinense Lour.	EL	II	Fr
Ligustrum yezoense Nakai	EE	II	Fl
Lonicera chamissoi Bge.	EL	II	Fr
Lonicera chrysantha Turcz.	EE	I	Fr
Lonicera edulis Turcz.	EL	I	Fr
Lonicera gibbiflora (Rupr.) Dipp.	EL	I	Fr
Lonicera glehnii Fr. Schmidt	EE	I	Fr
Lonicera maackii Maxim.	EE	I	Fr
Lonicera maximowiczii Rgl.	EE	I	—
Lonicera morrowii Gray	EL	I	Fr
Lonicera nigra L.	EL	I	Fr
Lonicera praeflorens Batal.	EL	I	Fr
Lonicera ruprechtiana Rgl.	EE	II	Fr
Maackia amurensis Rupr. et Maxim.	EE	I	Fr
Magnolia kobus DC.	LL	II	—
Malus baccata (L.) Borkh.	EE	I	Fr
Malus manshurica (Maxim.) Kom.	EE	I	Fr
Malus pallasiana Juz.	EE	I	Fr
Malus sieboldii (Reg.) Rehd.	EL	I	Fr
Menispermum dahuricum DC.	EE	VI	Fr
(Sorbus) Micromeles alnifolia (Sieb. et Zucc.) Koehne	EE	I	—
Morus alba L.	LE	II	Fr
Myrica tomentosa (DC.) Asch. et Graebn.	EL	II	Fr
Neillia sinensis Oliv.	EL	II	Fr
Orixa japonica Thunb.	EL	II	—
(Prunus) Padus asiatica Kom.	EE	I	Fr
(Prunus) Padus grayana C.K.Schneid.	EE	I	Fr
(Prunus) Padus maackii (Rupr.) Kom.	EE	I	Fr
(Prunus) Padus maximowiczii (Rupr.) Sok.	EE	I	Fr
(Prunus) Padus serrulata (Lindl.) Sok.	EE	I	—
Paulownia tomentosa (Thunb.) Steud.	LL	VI	—
(Prunus) Persica vulgaris Mill.	EL	II	Fr
Phellodendron amurense Rupr.	EE	I	Fr
Phellodendron chinense C.K.Schneid.	EE	II	—
Phellodendron japonicum Maxim.	EE	II	Fr

Phellodendron lavallei Dode	LL	V	—
Phellodendron sachalinense (Fr. Schmidt) Sarg.	EE	I	—
Philadelphus incanus Koehne	EE	I	Fr
Philadelphus schrenkii Rupr. et Maxim.	EE	I	Fr
Philadelphus tenuifolius Rupr. et Maxim.	EE	I	Fr
Photinia villosa (Thunb.) DC.	EL	II	Fr
Physocarpus amurensis Maxim.	EL	I	Fr
Physocarpus ribesifolia Kom.	EE	II	—
Populus davidiana Dode	EE	I	Fr
Populus koreana Rehd.	EL	I	—
Populus maximowiczii Henry	EL	I	—
Populus simonii Carr.	EL	I	—
Populus suaveolens Fisch.	EE	I	—
Prinsepia sinensis (Oliv.) Kom.	EE	II	Fr
Prunus salicina Lindl.	EE	I	Fr
Pterocarya rhoifolia Sieb. et Zucc.	LL	II	—
Pterocarya stenoptera DC.	LL	IV	—
Pyrus ussuriensis Maxim.	EE	I	Fr
Quercus dentata Thunb.	LL	II	—
Quercus mongolica Fisch.	EE	I	Fl
Quercus serrata Thunb.	LL	VI	—
Rhamnus dahurica Pall.	EL	I	Fr
Rhamnus japonica Maxim.	EE	I	Fr
Rhamnus schneideri Lévl. v. manshurica Nakai	EE	II	Fr
Rhamnus ussuriensis I.Vass.	EE	I	Fr
Rhamnus utilis Decne.	EL	II	Fl
Rhododendron dahuricum L.	EL	I	Fr
Rhododendron mucronulatum Turcz.	EL	II	Fl
Rhododendron schlippenbachii Maxim.	EL	I	Fl
Rhodotypos kerrioides Sieb. et Zucc.	EL	III	Fr
Ribes diacantha Pall.	EL	I	Fr
Ribes dikuscha Fisch.	EE	I	Fr
Ribes horridum Rupr.	EL	I	Fl
Ribes komarovii A.Pojark.	EE	I	Fr
Ribes mandshuricum (Maxim.) Kom.	EE	I	Fr
Ribes maximowiczianum Kom.	EE	I	Fr
Ribes pallidiflorum A.Pojark.	EE	I	Fr
Ribes pauciflorum Turcz.	EE	I	Fl
Ribes procumbens Pall.	EE	I	Fr
Ribes sachalinensis (Fr. Schmidt) Nakai	EE	I	Fr
Ribes triste Pall.	EE	I	Fl
Rosa acicularis Lindl.	EE	I	Fr
Rosa amblyotis C.A.M.	EE	I	Fr
Rosa davurica Pall.	EE	I	Fr
Rosa maximowicziana Rgl.	EE	II	Fr
Rosa multiflora Thunb.	EL	VI	Fr
Rosa rugosa Thunb.	EL	I	Fr
Rosa ussuriensis Juz.	EE	II	Fr
Rubus crataegifolius Bge.	EE	III	Fr
Rubus komarovii Nakai	EL	II	Fr

Rubus phoenicolasius Maxim.	EL	V	Fr
Rubus sachalinensis Lévl.	EE	II	Fr
Salix brachypoda (Trautv. et Mey) Kom.	EL	II	Fr
Salix floderusii Nakai	EL	I	Fr
Salix gracilistyla Miq.	EL	II	Fl
Salix hultenii Floder.	EE	II	Fr
Salix integra Thunb.	EL	II	Fr
Salix kanguensis Nakai	EL	I	Fr
Salix maximowiczii Kom.	EL	II	Fr
Salix rorida Laksch.	EL	II	Fl
Salix schwerini E.Wolf.	EL	II	Fl
Salix siuzewi O.V. Seem.	EL	II	Fr
Sambucus coreana (Nakai) Kom. et Alis.	EL	I	Fr
Sambucus latipinna Nakai	EE	II	Fr
Sambucus miqueli Nakai	EL	II	Fr
Sambucus sachalinensis Pojark.	EL	II	Fr
Sambucus sibirica Nakai	EL	II	Fr
Sambucus sieboldiana (Miq.) Schwer.	EL	I	Fr
Sasa kurilensis (Rupr.) Makino et Shibata	LL	I	—
Schizandra chinensis (Turcz.) Baill.	EE	II	Fr
Securinega suffruticosa (Pall.) Rehd.	LE	II	Fr
Solanum megacarpum Koidz.	LE	II	Fr
Sophora japonica L.	LL	VII	—
Sorbaria arborea C.K.Schneid.	EL	I	Fr
Sorbaria rhoifolia Kom.	EL	I	Fr
Sorbaria sorbifolia (L.) A.Br.	EE	I	Fr
Sorbus amurensis Koehne	EE	I	Fr
Sorbus commixta Hedl.	EL	I	Fr
Sorbus discolor (Maxim.) Hedl.	EL	I	Fr
Sorbus folgneri (Schneid.) Rehd.	EE	I	—
Sorbus hupehensis Schneid.	EL	I	—
Sorbus koehneana Schneid.	EL	I	Fr
Sorbus pohuashanensis (Hance) Hedl.	EE	I	Fr
Sorbus rufo-ferruginea (Schneid.) Schneid.	EL	I	Fr
Sorbus sambucifolia Roem.	EE	I	Fr
Sorbus schneideriana Koehne	EE	I	Fr
Sorbus sibirica Hedl.	EL	I	Fr
Spiraea albiflora (Miq.) Zbl.	EL	VI	Fr
Spiraea aquilegifolia Pall.	EL	II	Fr
Spiraea betulifolia Pall.	EE	II	Fr
Spiraea chinensis Maxim.	EL	II	—
Spiraea gemmata Sbl.	EL	I	Fr
Spiraea henryi Hemsl.	EL	II	Fr
Spiraea humilis A.Pojark.	EE	I	Fr
Spiraea japonica L.f.	EL	VI	Fr
Spiraea longigemmis Maxim.	EL	II	Fr
Spiraea media Fr. Schmidt	EE	I	Fr
Spiraea miyabei Koidz.	EL	II	Fr
Spiraea nipponica Maxim.	EL	II	Fr
Spiraea salicifolia L.	EE	II	Fr

Spiraea sericea Turcz.	EE	II	Fr
Spiraea thunbergii Sieb.	EL	IV	Fr
Spiraea trichocarpa Nakai	EL	II	Fr
Spiraea trilobata L.	EL	II	Fr
Spiraea ussuriensis A.Pojark.	EE	II	Fr
Spiraea veitchii Hemsl.	EL	II	Fr
Stephanandra tanakae Franch. et Sav.	EL	II	Fr
Syringa komarowi C.K.Schneid.	EL	II	Fr
Syringa microphylla Diels	EL	I	—
Syringa reflexa C.K.Schneid.	EL	I	Fr
Syringa sweginzowii Koehne	EE	I	Fr
Syringa velutina Kom.	EE	I	Fr
Syringa villosa Vahl.	EE	I	Fr
Syringa wolfi C.K.Schneid.	EE	I	Fr
Syringa yunnanensis Franch.	EL	I	Fr
Tilia amurensis Rupr.	EE	I	—
Tilia insularis Nakai	EE	I	Fl
Tilia japonica (Miq.) Simonk.	EE	I	Fr
Tilia mandshurica Rupr. et Maxim.	EE	I	—
Tilia maximowicziana Shiras	EE	I	—
Tilia taquetii C.K.Schneid.	EE		—
Tripterygium regelii Sprague et Tak.	EL	II	—
Ulmus laciniata (Trautv.) Mayr	EE	I	—
Ulmus propinqua Koidz.	EL	I	—
Ulmus pumila L.	EL	I	Fr
Vaccinium vitis-idaea L.	EL	I	Fr
Viburnum burejaeticum Reg. et Herd.	EL	I	Fl
Viburnum carlesii Hemsl.	EL	II	Fr
Viburnum fragrans Bge.	EL	III	Fr
Viburnum furcatum Blume	EE	I	—
Viburnum mongolicum (Pall.) Rehd.	EE	II	—
Viburnum sargenti Koehne	EL	II	Fr
Viburnum setigerum Hance	EL	II	Fr
Vitis amurensis Rupr.	EE	II	Fr
Weigela florida (Bge.) A.DC.	EL	I	Fr
Weigela middendorffiana (Carr.) C.Koch.	EL	I	Fr
Weigela praecox (Lemoine) Bailey	EL	I	Fr
Wisteria sinensis (Sims.) Sweet	LL	VI	—
Xanthoceras sorbifolium Bge.	LL	VII	—
Zanthoxylum simulans Hance	LL	VII	—

Acknowledgements

The author acknowledges the work of Dr. L. Plotnikova, Dendrology Department, Main Botanical Gardens, Moscow, who made the observations and collected the data in this study.

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Main Botanical Gardens
Moscow, U.S.S.R.

PLANTS WITH COLORFUL TWIGS IN EARLY SPRING

This year's weather has been a none-too-gentle reminder that March is still a winter month in New England. Color in the winter landscape is a subtle thing and comes largely from evergreens and the colored twigs of some deciduous shrubs and trees. As plant metabolic processes accelerate in early spring, the already colorful twigs of some plants become even brighter. The following shrubs and trees are outstanding for their stem color in winter and early spring:

Scientific Name	*Common Name*	*Stem or Twig Color*
Cornus alba 'Sibirica'	Siberian Dogwood	Coral red
C. sericea	Red-Osier Dogwood	Scarlet
C. sericea 'Flaviramea'	Goldentwig Dogwood	Yellow
Salix alba 'Tristis'	Golden Weeping Willow	Golden yellow
S. alba 'Chermesina'	Redstem Willow	Red-orange

The following plants are not so striking in twig color as those listed above, but are still relatively colorful when in high vigor:

Ceanothus ovatus	Inland Ceanothus	Reddish pink
Cornus alba	Tatarian Dogwood	Crimson
C. alba 'Kesselringii'	Purpletwig Dogwood	Purplish
C. amomum	Silky Dogwood	Dark reddish
C. rugosa	Roundleaf Dogwood	Olive green to rosy scarlet
C. sanguinea 'Bloodtwig'	Dogwood	Dark reddish
C. sanguinea 'Viridissima'	Greentwig Dogwood	Yellow-green
C. sericea 'Kelseyi'	Kelsey Dwarf Dogwood	Dark reddish
C. sericea 'Nitida'	Greentwig Dogwood	Green
Forsythia viridissima	Greenstem Forsythia	Green
Kerria japonica	Kerria	Green
Rosa virginiana	Virginia Rose	Red
Salix daphnoides	Daphne Willow	Olive to scarlet, bloomy

Vigorous growth is important for best development of stem color in most of these plants. One of the simplest ways of maintaining a high state of vigor is to prune heavily. All of the shrubs listed can be pruned almost to the ground occasionally, some more often than others. Plants like *Kerria*, *Forsythia viridissima*, and most species of *Rosa* should be pruned this severely only once in 3 to 5 years, while any willow kept as a shrub will probably require severe pruning at least every 2 or 3 years. The dogwoods with colorful twigs are also best when pruned severely every 2 or 3 years, or even annually.

HARRISON L. FLINT

1967 Spring Classes at the Arnold Arboretum

Field Class, Jamaica Plain **Friday Mornings, 10 a.m.–noon**
April 28–May 26

Informal outdoor talks and field trips on the grounds of the Arnold Arboretum, Jamaica Plain, Mass., will be directed by Dr. Donald Wyman and the Arboretum's horticultural staff. This is a continuation of the class which has been offered for many years and in which the various plants are studied as they come into bloom. In case of rain, meetings are held indoors. Those attending will meet at the Administration Building, Jamaica Plain entrance. There will be five sessions on Friday mornings.

Registration fee $2.00

Field Class, Case Estates, Weston **Wednesday 2:30–4:30 p.m.**
April 26–May 24

There will be five informal field classes on the Case Estates in Weston, led by Dr. Gordon DeWolf. Emphasis will be placed on the means of recognizing the spring flowering plants, both wild and cultivated. Classes will meet at the parking area near the Barn at 135 Wellesley Street. In case of rain, meetings will be held indoors. A hand lens or magnifying glass is desirable equipment. Registration fee $2.00

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BOTANICAL GARDEN

ARNOLDIA

A continuation of the
Bulletin of Popular Information
of the Arnold Arboretum, Harvard University

Volume 27 MAY 12, 1967 Number 3

HOW TO HAVE A GOOD CLIPPED HEDGE

FIRST, decide whether you really want a hedge. Remember that a clipped hedge is not a low-maintenance planting. Remember too that it is formal in effect, and at its best in a relatively formal setting — in other situations an informal hedge or shrub border may accomplish as much and be more in harmony with its surroundings.

Starting a Hedge

Before starting a new hedge, decide what you want it to accomplish. Will its purpose be to gain privacy or to block an undesirable view? Or do you want to use it for a low divider and leave a good view over it? Perhaps it will serve as a barrier as well as a screen. If so, selection of plants will be restricted to those that will make a strong dense framework, and those with thorns or prickles.

Consider also the amount of space available. Some plants require a base width equal to their height for good results. If your hedge must be six feet tall, can you spare a 6-foot width of ground for it? If not, limit your selection of plants to those of upright habit that will form a tall but narrow wall or, as an alternative, build a fence. Many of the columnar forms of trees and shrubs can be used in such a situation. Remember though, that many plants with this habit tend to become open at the base and are kept full only by careful maintenance.

Many kinds of plants can be used for hedges, but not all. Ask yourself these questions:

1. *Do I need an evergreen hedge?* Many evergreen plants make good hedges that function as well in winter as they do in summer. Deciduous hedges grow faster, reach useful size more quickly, and usually require more frequent pruning. They are usually less expensive initially than evergreen hedges.

2. *Will the plant I select make full, bushy growth?* Most woody shrubs will, but some are weak hedge plants, especially growing in shade. Some parts of even

the best-shaped hedge must grow in considerable shade from upper branches — but should still remain bushy. Some shrubs are excellent when allowed to grow informally but lose their character when sheared, so make dismal formal hedges. Take time to look at hedges in your area and see which kinds of plants are performing best.

3. *How much do I want to spend for plants?* Some of the best deciduous hedges have been started with plants under one foot tall. When this is done, pruning can be started close to the ground and you have control over the entire framework of the plants. This is the way to make a hedge hug the ground.

Evergreen hedges can be started with small plants, too, but this means waiting an extra 5 years or more for the hedge to reach useful size.

The following lists include only a few of the plants that have made successful clipped hedges in reasonably good cultural situations. Many other species are excellent choices in certain situations. Still others that are of secondary value may still prove useful in problem situations. When problem situations exist, you'll want to consult the lists of hedge plants for special situations in Dr. Wyman's book* on shrubs and vines.

A Few of the Best Plants for Clipped Hedges

Low hedges (knee high)

Scientific Name	Common Name	Hardiness Zone (Arnold Arboretum Map)
Deciduous:		
Berberis buxifolia nana	Dwarf Magellan Barberry	5
Berberis thunbergii minor	Dwarf Japanese Barberry	4
Caragana pygmaea	Pygmy Peashrub	3
Physocarpus opulifolius 'Nanus'	Dwarf Ninebark	2
Salix purpurea 'Nana'	Dwarf Purple Osier Willow	4
Viburnum opulus nanum	Dwarf European Cranberrybush	3
Evergreen:		
Buxus microphylla koreana	Korean Box	5
Buxus sempervirens 'Suffruticosa'	Truedwarf Box	5
Ilex crenata 'Helleri'	Heller Japanese Holly	6 (5?)
Picea abies dwarfs	Dwarf Norway Spruces	2
Taxus cuspidata 'Nana'	Dwarf Japanese Yew	4
Thuja occidentalis 'Little Gem'	Little Gem Arbor-vitae	3

Medium hedges (below eye level):

Scientific Name	Common Name	Hardiness Zone (Arnold Arboretum Map)
Deciduous:		
Berberis × *mentorensis*	Mentor Barberry	5
Berberis thunbergii and	Japanese Barberry	4
var. *atropurpurea*	Redleaf Japanese Barberry	4

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* Wyman, Donald. Shrubs and Vines for American Gardens. Macmillan, New York. 1949.

Medium hedges — *continued*

Cornus mas	Cornelian Cherry	4
Euonymus alatus	Winged Euonymus	3
Euonymus alatus 'Compactus'	Dwarf Winged Euonymus	4
Ligustrum ovalifolium	California Privet	5
Rhamnus frangula	Alder Buckthorn	2
Rosa rugosa	Rugosa Rose	2
Syringa chinensis	Chinese Lilac	4
Viburnum dentatum	Arrowwood	3
Viburnum prunifolium	Black Haw	3

Evergreen:

Buxus sempervirens	Common Box	5
Chamaecyparis pisifera (shrubby varieties)	Sawara False-cypress	4
Ilex crenata cultivars	Japanese Hollies	6 (5?)
Taxus cuspidata cultivars	Japanese Yew	4
Taxus media cultivars	Anglojap Yew	5
Thuja occidentalis 'Robusta'	Ware Arbor-vitae	3
Tsuga canadensis	Canada Hemlock	3
Tsuga caroliniana	Carolina Hemlock	4

Tall hedges (above eye level):

Deciduous:

Acer campestre	Hedge Maple	5–6
Acer ginnala	Amur Maple	3
Crataegus crus-galli	Cockspur Hawthorn	4
Fagus grandifolia	American Beech	3
Fagus sylvatica	European Beech	4
Quercus imbricaria	Shingle Oak	5
Salix pentandra	Laurel Willow	4
Syringa amurensis	Amur Lilac	3
Viburnum lentago	Nannyberry	2

Evergreen:

Picea abies	Norway Spruce	
Pinus strobus	Eastern White Pine	3
Thuja occidentalis	American Arbor-vitae	3
Tsuga canadensis	Canada Hemlock	3
Tsuga caroliniana	Carolina Hemlock	4

Pruning a Hedge

Pruning a hedge is an art, but also a science. Many hedges are failures because the science of pruning was ignored — which is unfortunate, because it's really very simple:

1. *Prune heavily when planting a hedge.* This will help to establish balance between the tops of the plants and the root systems that have been reduced in digging. It will also promote low branching. Deciduous plants should be pruned more heavily than evergreens at planting.

2. *Shear lightly and often*, once the hedge is established and growing, to avoid a "chopped" look. Prune deciduous hedges 2 to 4 times each summer, even more often in a few cases. Most evergreen hedges need to be pruned only once, in June. In a few cases, a second shearing in late July or early August is necessary.

3. *Don't shear too late in summer.* This may result in a "new haircut" look all winter, as many plants make no more new growth after July. In some cases, late pruning will stimulate late growth and can lead to winter injury.

As a general rule, shear for the last time before night temperatures begin to fall into the 40's with any frequency. This means by August 1 in much of northern New England and by August 15 or 20 in most of southern New England. Plants that complete growth in mid-summer should not be pruned after June. These include lilacs, crab apples, maples, deciduous species of *Euonymus*, and others.

4. *Shear to a broad base.* Never prune a hedge in a vase shape — wider at the top than at the base. This is probably the most common single cause of failure. Ideally, keep the base even wider than the top. This allows the lower parts maximum exposure to sun (see Plate I).

Fertilization and Watering

It seems paradoxical that we would want to stimulate vigorous growth in a hedge and then cut it off. But, up to a point, that is precisely the objective. A hedge that is allowed to lose vigor can be sheared very little and is difficult to repair if it is damaged. But this does not mean that a hedge must be kept extremely vigorous. If too vigorous, a hedge plant, like any other, can be injured by cold in early winter, but a plant in poor vigor can also be prone to winter injury. So moderation is the rule here, as in most other garden activities.

Pruning itself tends to maintain vigor, but occasional fertilization is usually necessary in addition. Probably the easiest way to fertilize a hedge is to spread lawn fertilizer up to 6 inches from the base of it when the lawn is being fertilized in April. If the lawn receives a second application in June, it doesn't need to be applied close to the hedge.

For most hedges, 2 to 3 lbs. of a 10-10-10 or 8-6-4 fertilizer (or similar) for each 100 square feet of ground covered is ample for one year. In a reasonably fertile garden soil, this amount in alternate years should be enough.

Regular watering of an established hedge is not necessary, but occasional soaking during drought periods is a good idea where restrictions on water use don't prevent it. The same rules that apply to watering a lawn hold here also. *Never sprinkle* — always soak to a depth of at least 6 inches. Then wait until the soil begins to dry before watering again. Watering lightly every evening is one of the surest ways to damage a hedge — or a lawn.

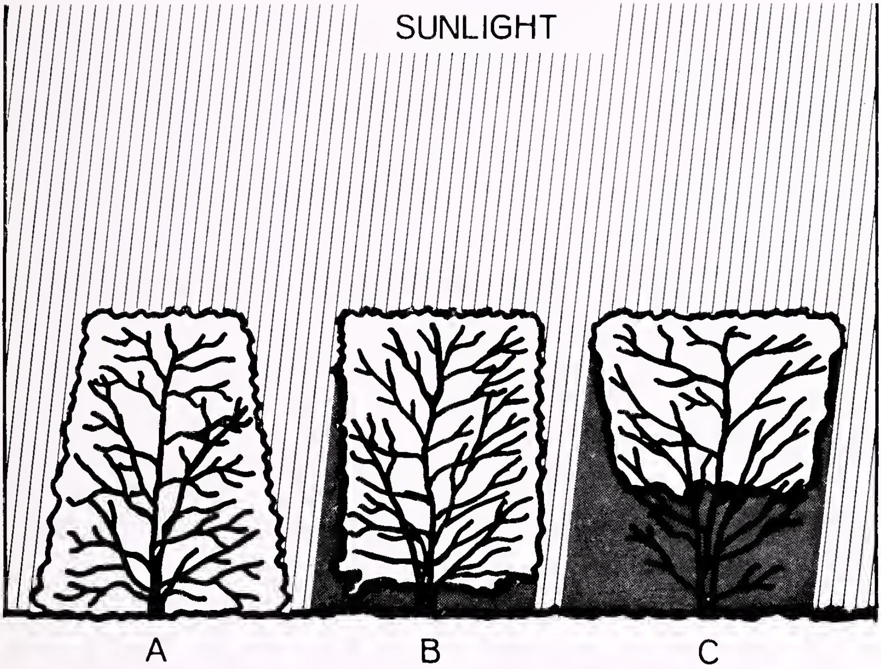


PLATE I

For best results, hedges should be pruned with the sides sloping inward (A) so that the entire outer surface is exposed to sunlight. Shearing with vertical sides (B) gives fair exposure to light and most hedges treated this way can be kept in fair condition. If a hedge is pruned with sides sloping outward (C), the lower branches will be in the shade most of the time, and the hedge will gradually become defoliated toward the base.

Hedge Demonstration Plantings

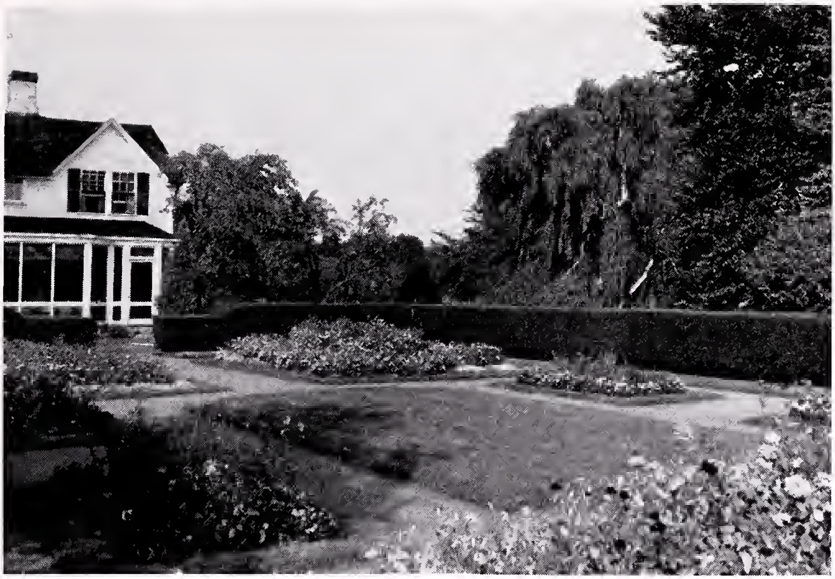
Before making a final selection of hedge plants, you may want to look at examples of hedges in your area. One of the best ways of doing this is to visit a hedge demonstration planting. Such plantings are not available in every area or even every state, but there are quite a few scattered over the U.S. and Canada.

The oldest hedge demonstration plantings in North America are those at the Central Experimental Farm, Canada Department of Agriculture, Ottawa. A few of the hedges there were planted before 1900 and are still in excellent condition.

The Arnold Arboretum hedge demonstration plantings were started in 1936 on the old Bussey Institution grounds on South Street. When the Charles Stratton Dana Greenhouses were constructed in 1962, the area containing the old greenhouse and hedge plantings was abandoned. At that time 35 of the hedges were moved to a new area near the new greenhouses, and more than 55 new hedges were started in the same area (*Arnoldia*, vol. 24, no. 11). This new hedge planting was started just prior to the beginning of the 1963–1966 drought, and many of the plants have been slow in becoming established as good examples of clipped hedges. The current relative abundance of moisture should bode well for their future condition.

Other extensive hedge plantings in the northeastern U.S. and adjacent Canada include those at Cornell University's Test Gardens and at the Montreal Botanical Garden. The Morton Arboretum, Lisle, Illinois, has had extensive hedge plantings for many years and hedge demonstrations have been started in several other places in the U.S. and Canada in recent years.

HARRISON L. FLINT



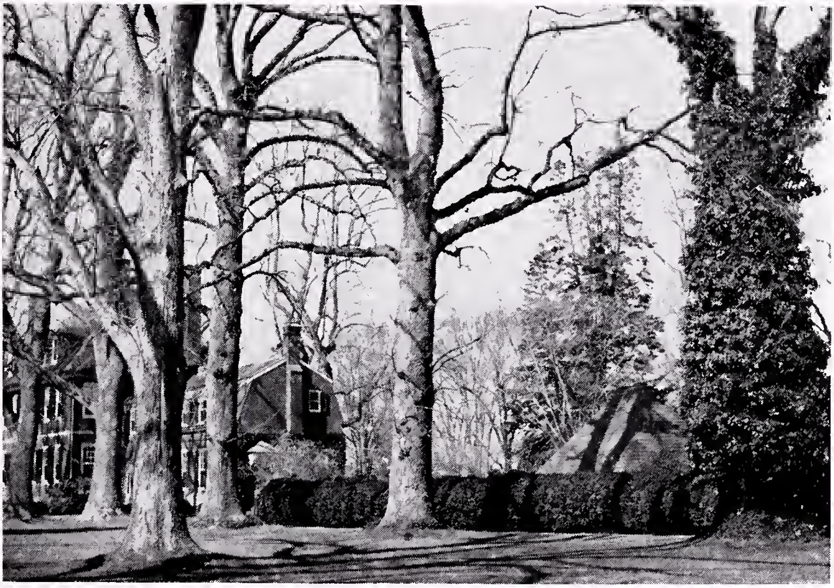
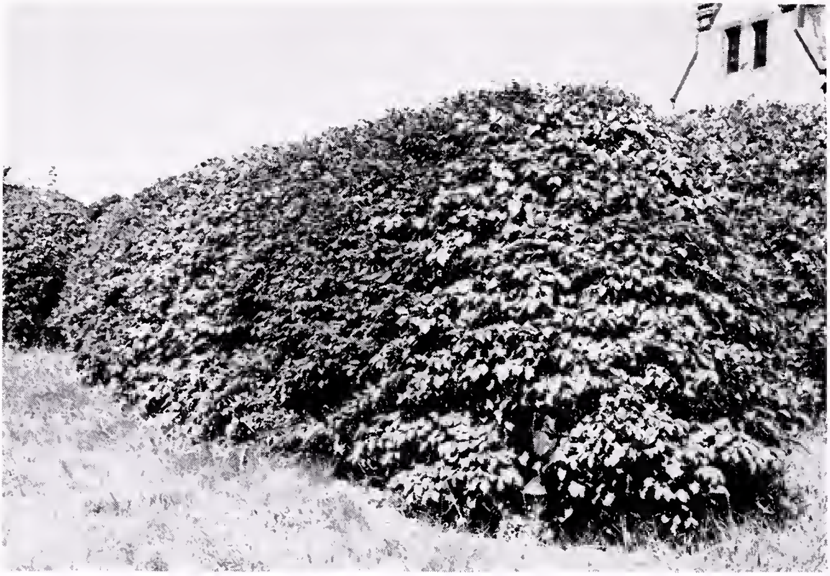


PLATE II

Two of the finest evergreen hedge plants are the yew (*Taxus* spp.) and common box (*Buxus sempervirens*). The closely sheared yew hedge in Hamilton, Mass. (top) is well used to enclose a formal annual flower garden. The common boxwood, used in this very old hedge in James River, Virginia (bottom) requires a minimum of pruning because of its slow growth and bush habit. Boxwood hedges of this size are seldom found in most of New England, but may become more common with the proliferation of "hardy" cultivars.



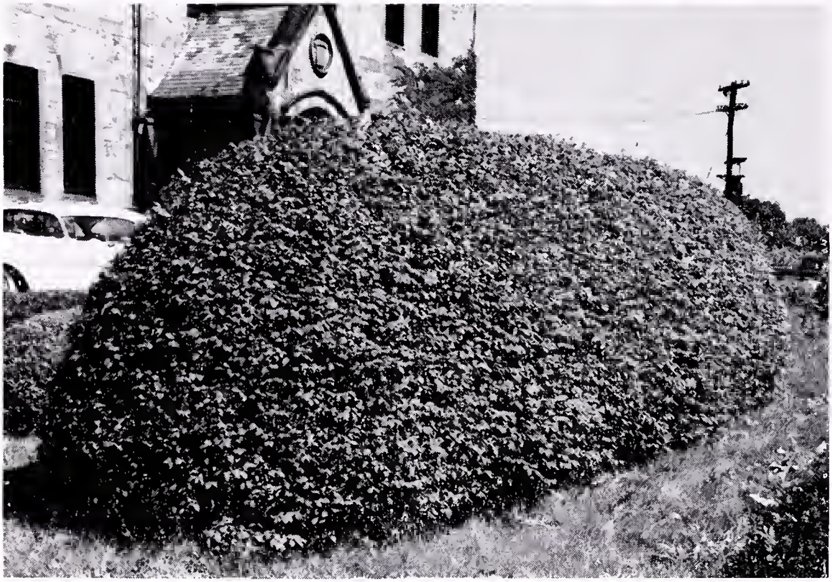


PLATE III

Two of the finest deciduous shrubs for hedge use are Black Haw (*Viburnum prunifolium*) (top) and Dwarf Winged Euonymus (*Euonymus alatus* 'Compactus') (bottom). Black Haw left unpruned will eventually reach a height of 12 to 15 ft., but it grows rather slowly and can be kept as a hedge below eye level without difficulty. Its lustrous foliage turns a good red in autumn.

Dwarf Winged Euonymus is not a true dwarf, but does grow considerably more slowly than the species (*Euonymus alatus*) and has equally good flame-red autumn foliage. A word of caution: the cultivar 'Compactus' is not so hardy as the species, and is damaged in some winters in parts of Zone 4.

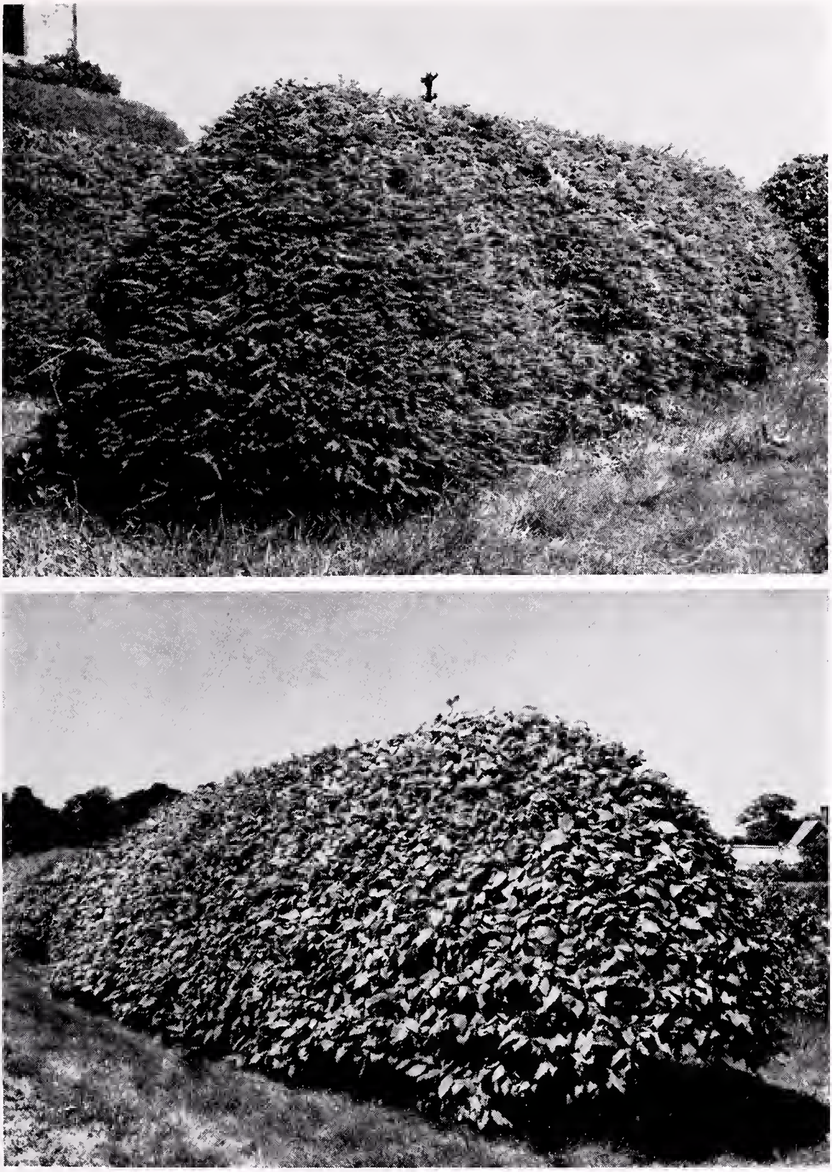


PLATE IV

Two native tree species, Canada Hemlock (*Tsuga canadensis*) (top) and American Beech (*Fagus grandifolia*) (bottom), are among the finest plants for tall hedges, but can be kept below eye level for many years with heavy pruning.

Canada Hemlock recovers from shearing quickly and is almost foolproof as a hedge, except near the ocean or in extremely exposed situations. Even in the most formal outline, it retains its airy texture,

American Beech is often slow starting, but once well-established grows reasonably fast and is well worth waiting for.

PLATE V

There are few plants that cannot be used successfully for making a hedge. This fact is borne out by this reasonably good hedge (top) of Norway Maple (*Acer platanoides*).

Two better maples for hedge use are shown in the bottom photo. The Hedge Maple (*Acer campestre*) (left) has been widely used in Europe for this purpose and is hardy in Zone 5. The Amur Maple (*Acer ginnala*) (right) is almost as good a hedge plant as the Hedge Maple. It is hardy in Zone 3 (northern Maine, for instance), and even colder areas, and its foliage turns brilliant scarlet in autumn.

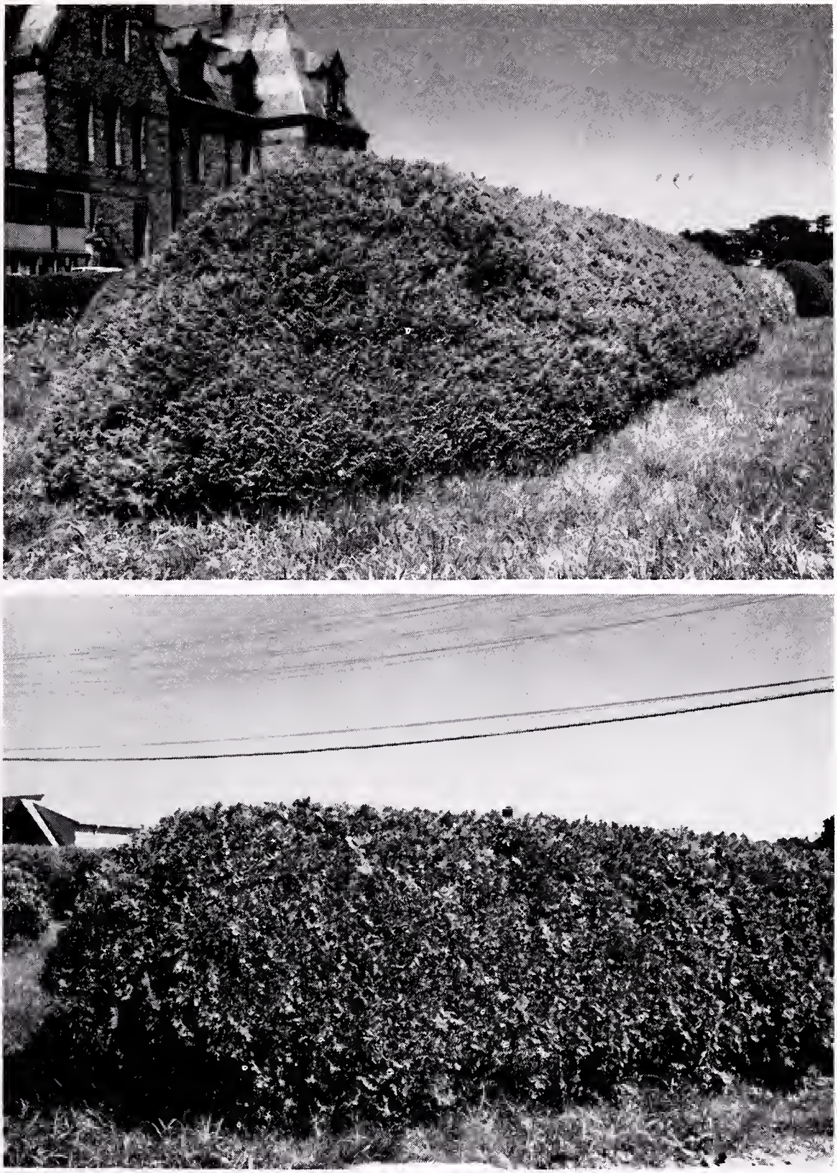


PLATE VI

Sawara False-cypress (*Chamaecyparis pisifera*) and American Arbor-vitae (*Thuja occidentalis*) are among the most successful fast-growing evergreens for hedge use. Because of this they are often used in preference to better but slower-growing plants.

The Plume Sawara False-cypress (*Chamaecyparis pisifera* 'Plumosa') (top) is one of the best varieties for hedge use, as it is extremely bushy in growth habit. This and other varieties may winter-burn somewhat in Zone 4 and colder.

The Ware Arbor-vitae (*Thuja occidentalis* 'Robusta') (bottom) is one of the best cultivars for a medium-size hedge. For a tall hedge, the cultivar 'Douglasii Pyramidalis' is superior, as it is more upright in form. Ordinary wild seedlings of *Thuja occidentalis* can be used successfully in a hedge, but usually require more attention to pruning than the better cultivars.

DR. GORDON P. DEWOLF, JR., APPOINTED HORTICULTURAL TAXONOMIST AT THE ARNOLD ARBORETUM

Dr. Gordon P. DeWolf, Jr. was appointed Horticultural Taxonomist at the Arnold Arboretum effective March 15, 1967. Dr. DeWolf is a native of Chelmsford, Massachusetts and received the B.Sc. degree from the University of Massachusetts, M.Sc. degrees from Tulane University and the University of Malaya in Singapore, and the Ph.D. from the University of Cambridge (England). His study at the University of Malaya (1952–53) was supported by a Fulbright Grant.

During undergraduate and graduate study, Dr. DeWolf also worked at the International Institute of Agricultural Sciences in Costa Rica, in the Harvard University Herbaria, and as a graduate research assistant at Tulane. He has been employed as a Research Associate at the Bailey Hortorium of Cornell University, and as Senior Scientific Officer at the Colonial Office in London, working at the Royal Botanic Gardens at Kew. From 1961 until this year, Dr. DeWolf was Associate Professor and then Professor of Botany at Georgia Southern College.

Dr. DeWolf is married and has three children. He has had the honor of being elected a Fellow of the Linnean Society of London and is a member of several national and international botanical societies. He is the author of numerous scientific articles over the past several years. At the Arnold Arboretum he will be working on problems of horticultural taxonomy and nomenclature, and continuing his current research efforts in studying relationships in the genera *Ficus* and *Dorstenia* in Africa and the American Hemisphere.

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A continuation of the
BULLETIN OF POPULAR INFORMATION
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VOLUME 27 JUNE 23, 1967 NUMBERS 4-5

DWARF CONIFERS FROM WITCHES'-BROOMS

THE English term *witches'-broom* translates directly from the German word *Hexenbesen*. Both parts of the German compound word are found in English as *hex*, meaning to bewitch, and *besom*, a bundle of twigs (usually of birch) bound together to form the age-old do-it-yourself sweeping implement still used by people in rural Europe. Plate VII shows a witches'-broom development commonly found on highbush blueberry in New England. It bears a strong resemblance to a broom. In this instance the thread-like mycelium of a rust fungus has invaded the stem and stimulated mass development of latent buds.

It seems only natural that medieval Europeans would call these peculiar growths witches'-brooms, for they were accustomed to brooms made from bundles of twigs and were inclined to relate anything mysterious and unexplainable to witchcraft.

Many superstitions were associated with witches'-brooms and they played an important part in medieval folklore. A library search by the author for information in English folklore proved fruitless, but Dr. Richard S. Meriam, Professor Emeritus in the Harvard Business School, kindly volunteered to search the German literature at Harvard's Widener Library and found the following. The German word *Hexenbesen* is now used to define only witches'-brooms and mistletoe, but in the past it was applied to other woody growths as well. It was once one of several words used to describe such abnormalities—they were also called witches'-nests (*Hexennester*) mares'-nests (*Mahrnester*), and thunderbrooms (*Donnerbesen*). Witches not only caused these formations—they also used them as nests and resting places during their travels. They were also used by elves, hobgoblins and other evil and oppressive spirits. Among them were the mares (*Mahre*), who were thought to sit on the chests of sleeping persons and bring on bad dreams—the origin of our word *nightmare*. We cannot be sure that all the tales apply solely to witches'-brooms as we know them, for some other unusual growths may have been involved. A special use of the witches'-broom, of course, was for the witch to mount it and ride through the air. The ancient belief in witches'-brooms and thunderbrooms ascribed magical protective and healing powers to them. They protected against sickness and lightning and, curiously enough, against witchcraft itself. In Silesia, a witches'-broom of birch hung in a pigpen protected the animals from the work of witches and disease.

Modern scientific literature abounds with references concerning the investigation of witches'-brooms. They have been found on many species of woody and non-woody plants, and have been shown to result from the stimuli of feeding mites and insects and parasites such as fungi, bacteria, viruses, and one of the higher plants—dwarf mistletoe (*Arceuthobium pusillum*).

Plate VIII shows a spruce tree with numerous witches'-brooms—in this case they are symptoms of infection. In some areas all trees of a given species bear such developments, and some stunted specimens are comprised entirely of brooms. Many people are familiar with the brooms that appear so commonly on trees of hackberry (*Celtis occidentalis*). These are thought to be induced by mites in association with a fungus.

Despite the abundance of literature on witches'-brooms in general, few references relate to those that have arisen in the absence of causal organisms, presumably through "bud sports" or mutations. This paper, however, deals with these brooms that appear to be of genetic origin. Such witches'-brooms are relatively common when one has developed an eye for spotting them. During a recent trip to Cape Cod to collect scions of one broom, three other isolated specimens were found. The following Sunday a tour through southeastern Massachusetts led to the discovery of six more. When seeking brooms, a wide and careful search has always been made in the area where one was found, to see if others might be present. In these searches, two brooms have never been found on a single pine tree, and in only one instance has a second been seen within 100 feet of the first. Usually they are many miles apart. This, and the fact that they are free of excessive dead parts would tend to support the belief that they are not caused by organisms. A large number of dictionaries, encyclopedias, and technical publications checked by the author have defined witches'-brooms as developments arising through the action of causal organisms. In the event that brooms such as those discussed in this paper prove to be free of such agents, a new term to define them may well be needed.

To bring superstitions up to date it should be noted that witches'-brooms were found in eleven cemeteries and correspondents have mentioned brooms as occurring in seven others.

Development of Witches'-brooms from Single Buds

Plate IX shows a witches'-broom collected from a local eastern white pine (*Pinus strobus*). How it came about can best be explained by describing how pine trees of this type grow. With the advent of spring, the cluster of buds located at the tips of the previous year's growth become active and develop into new

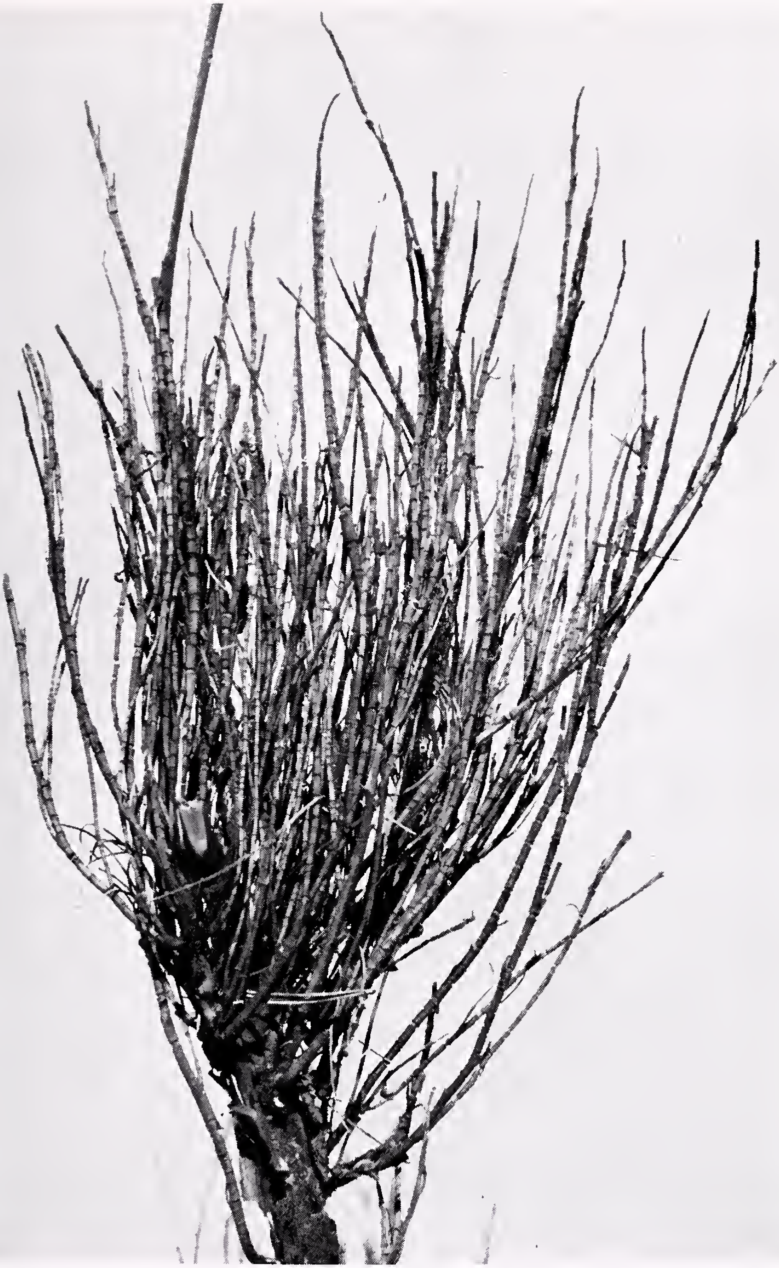

PLATE VII

Witches'-broom development commonly found on highbush blueberry.

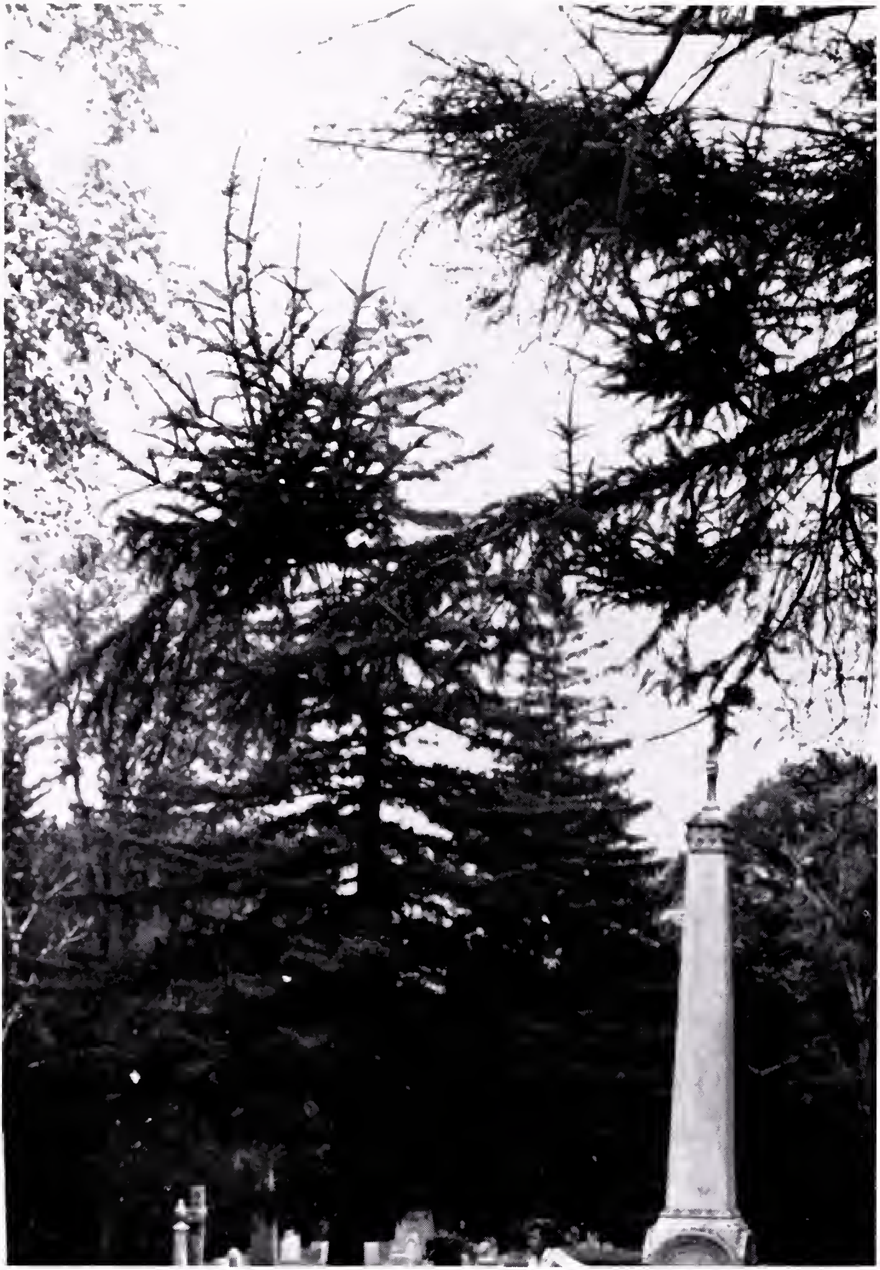

PLATE VIII

A spruce tree with numerous witches'-brooms — in this case they are symptoms of infection.

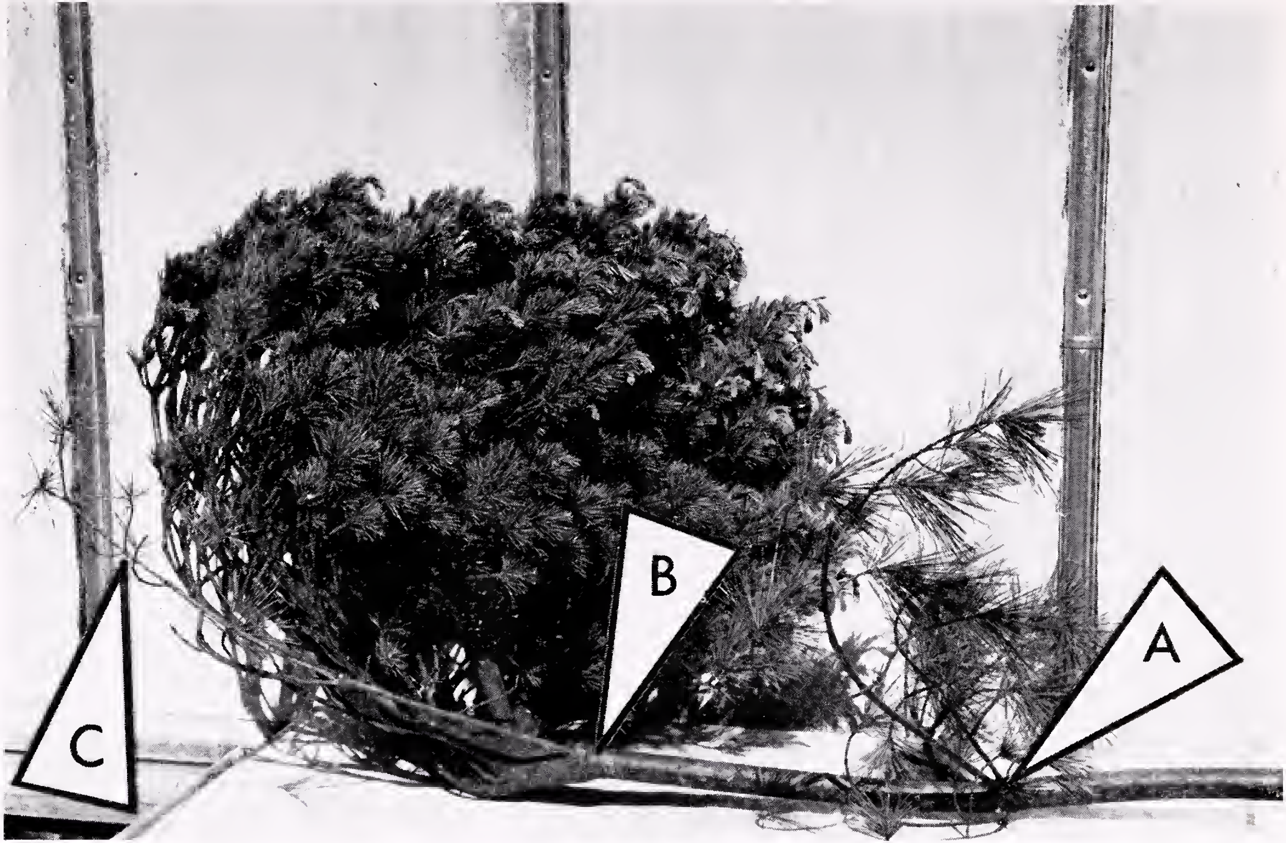

PLATE IX

Witches'-broom of white pine illustrating how this particular development is traceable to growth changes that took place within the growing point of a single bud (see text).

shoots. During their elongation period such new growths are commonly termed "candles". The time of this activity depends upon location and season—last year in the Boston area it commenced about May 1 and in a scant three weeks the new set of buds had formed.

Plate X (inset) shows a terminal shoot of Scots pine (*Pinus sylvestris*) with a cluster of winter buds. When growth takes place the central bud will develop into a terminal or leading shoot, while those surrounding it will develop into lateral or side shoots. In preparation for the next annual growth cycle, each "candle" will again terminate in a cluster of buds.

Plate X (left) illustrates how successive terminal growths of a young Scots pine have led to elongation of the trunk and side branches while lateral growths have formed branches in whorls. Thus each year's growth adds to the framework of the tree, leading to an increase in height, breadth and density. The result of such development is shown in the structure of an ailing and partly defoliated roadside pine (Plate X, right).

Returning to Plate IX, we find a clear-cut illustration of how this particular development is traceable to growth changes that have taken place within the growing point of a single bud. At (A) is a whorl of six normal lateral branches together with a normal leading shoot that terminated its growth and set buds at (B). Leaves on these normal branches measured from $2\frac{1}{2}$ to $3\frac{3}{4}$ inches in length. The following year a new set of six branches arose at (B), together with a terminal shoot. One of the lateral buds underwent changes that gave rise to the broom. The other five lateral branches were positioned beneath the broom where through the years they were too deeply shaded to survive, and their scars are just discernible at (B). The terminal shoot (C), normal in character, had enough light to continue as a spindling growth. It has developed to about pencil thickness while in the same period the broom has become a dense, multibranched, globose mass, 26 inches wide and 23 inches tall, with a basal stem $1\frac{7}{8}$ inches thick. Its leaves, borne on short, thicker-than-normal shoots, measure $\frac{7}{8}$ to 1 inch in length.

Examples of Witches'-brooms Arising from Single Buds

The broom on red pine (*Pinus resinosa*) shown in Plate XI (top) is the lone survivor in a branch whorl that came into being many years ago. Its leaves are darker in color than those of normal branches on the tree on which it is borne, and it presents an appearance of thrift. Although all other members of the whorl have perished, the broom has managed to survive and prosper.

Plate XI (bottom) shows a broom on pitch pine (*Pinus rigida*). It is positioned about four feet above ground in the remains of a whorl of branches. Although its host and other trees in the area reflect the impoverished, sandy Cape Cod soil in which they grow, the broom is darker green in color and appears healthy and vigorous. It has been under observation for six years and during the past growing season produced a few pistillate conelets for the first time.

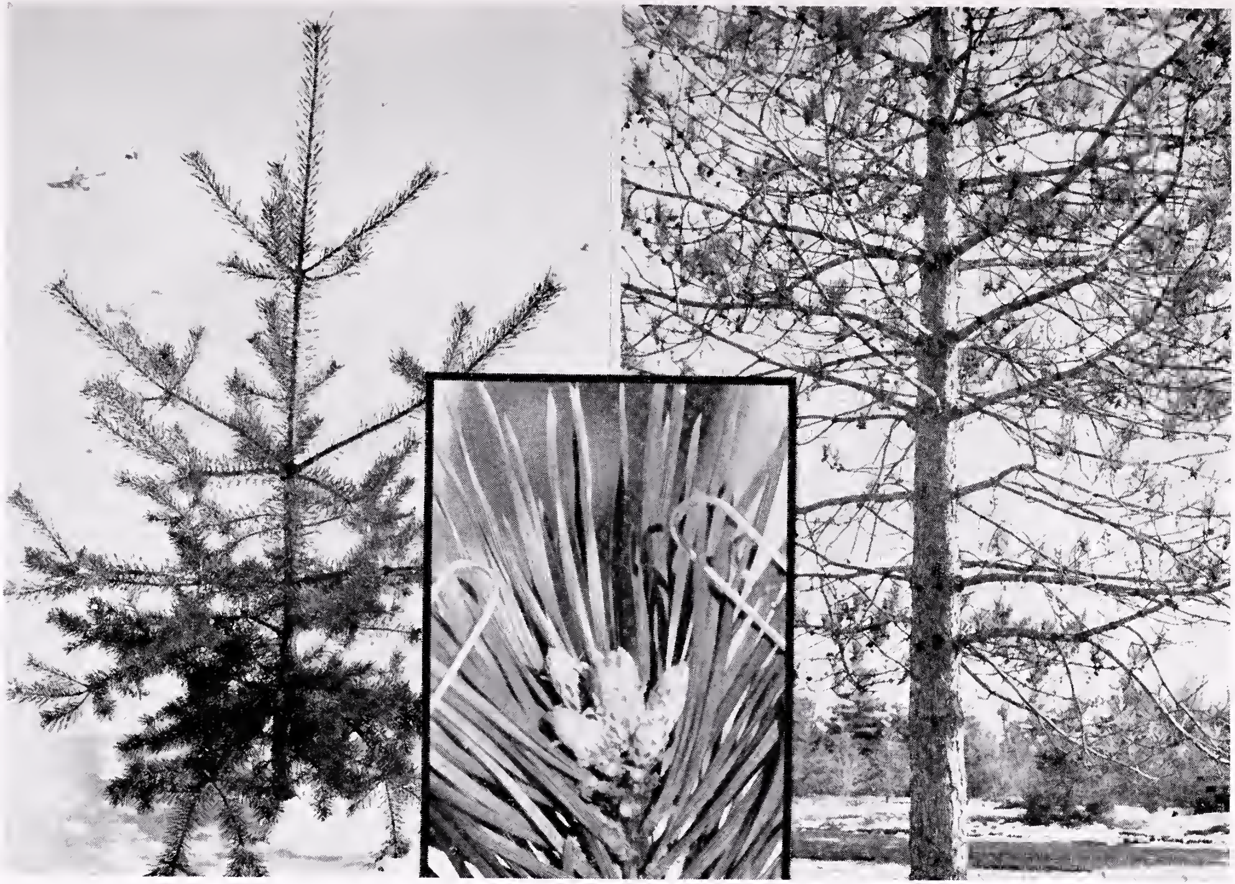

PLATE X

(Inset) Scots pine terminal shoot showing a cluster of winter buds. (Left) Terminal growths of a young Scots pine have led to an elongation of the trunk and side branches while lateral growths have formed branches in whorls. (Right) The result of these developments is shown in the structure of an ailing and partly defoliated roadside pine.

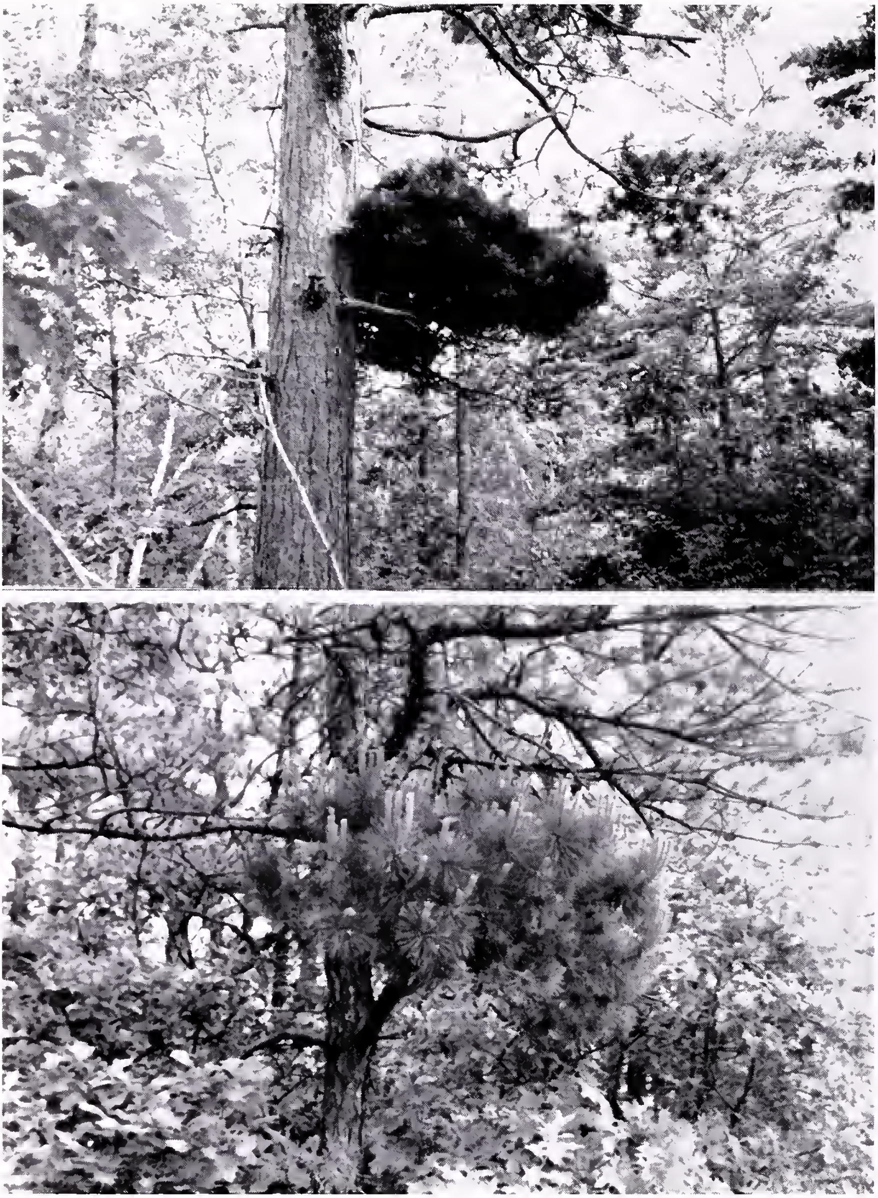

PLATE XI

(Top) Broom on red pine is the lone survivor in a branch whorl that came into being many years ago. (Bottom) Broom on pitch pine positioned in the remains of a whorl of branches.

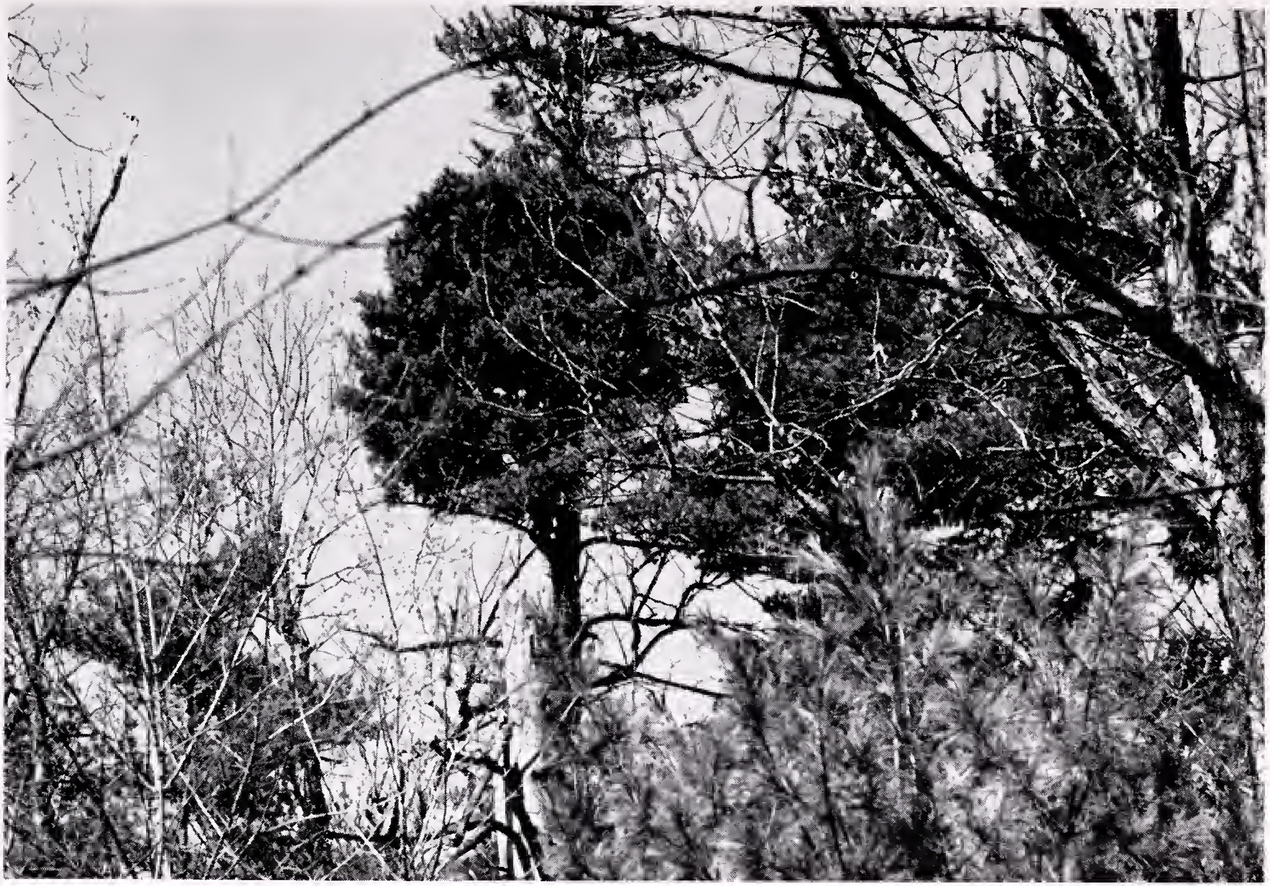

PLATE XII

A broom situated about 2/3 of the way up the trunk of a 60 foot white pine tree. This and some others so positioned resemble independent trees attached to the host plants.

A broom situated about $\frac{2}{3}$ of the way up the trunk of a sixty foot white pine tree is shown in Plate XII. It is clear that this, too, originated from a lateral bud, for it is located in the remains of a whorl of branches. This and some others so positioned resemble independent trees attached to the host plants.

Plate XIII shows a massive witches'-broom comprising the entire crown of a white pine approximately 50 feet tall. Although witches'-brooms may be found on any part of a plant (where parasites invade or where growth changes take place within a bud), terminal brooms are more prominent and therefore more readily discovered. Because of this crowning position they can sometimes be spotted against the far distant skyline. Others, located on lower parts of trees, can be found more easily in winter when deciduous trees are bare than in summer when they may be obscured by woodland foliage.

Dwarf Seedlings in Nature from a Pine Witches'-broom

Plate XIV shows a terminal witches'-broom on eastern white pine (*Pinus strobus*) located in the Berkshire Hills of Western Massachusetts. What appears to be two trees is actually one that divides into two parts four feet above the ground. The broom, terminating one leader, is about 10 feet tall and 10 feet wide. Its clean growth shows no evidence of causal agents. It is of special interest because it has borne viable seeds that have given rise to numerous dwarf plants. The tree is situated at the edge of a clearance fifty yards wide cut through woods to accommodate high-tension electric lines. As a result of the unnatural opening in the woods, seeds shed from the broom have had a better chance of developing into plants than would have been the case in undisturbed woodland where slow-growing plants are at a serious competitive disadvantage.

Cones from the broom showed a diversity of subnormal sizes, when compared with normal white pine cones (Plate XV). Those from the normal tree (left) measured from $4\frac{3}{4}$ to $5\frac{1}{2}$ inches in length, while the ones produced on the witches'-broom (right) varied from $1\frac{3}{4}$ to $3\frac{5}{8}$ inches, most being less than $2\frac{1}{2}$ inches long. White pine cones have five clearly defined sets of spirally arranged cone-scales fixed to a central axis. Though not always clearly defined, this same arrangement was found in cones from the witches'-brooms. However, the number of scales present varied enormously. Scales on 25 witches'-broom cones were counted and the number ranged from 20 to 50, while normal cones bore between 68 and 80. In the witches'-broom cones, there was no relationship between cone length and scale number — the shortest had 25 scales, while the longest had only 21. However, seed size did vary, the small cones containing proportionately small seeds.

Through the years, more than 250 pines exhibiting genetic dwarfism have arisen in the vicinity of the broom-bearing tree, some as far distant as one-quarter mile. Seeds collected from this broom were germinated at the Arnold Arboretum and 48% of the seedlings showed dwarfism (1198–63, Table I).

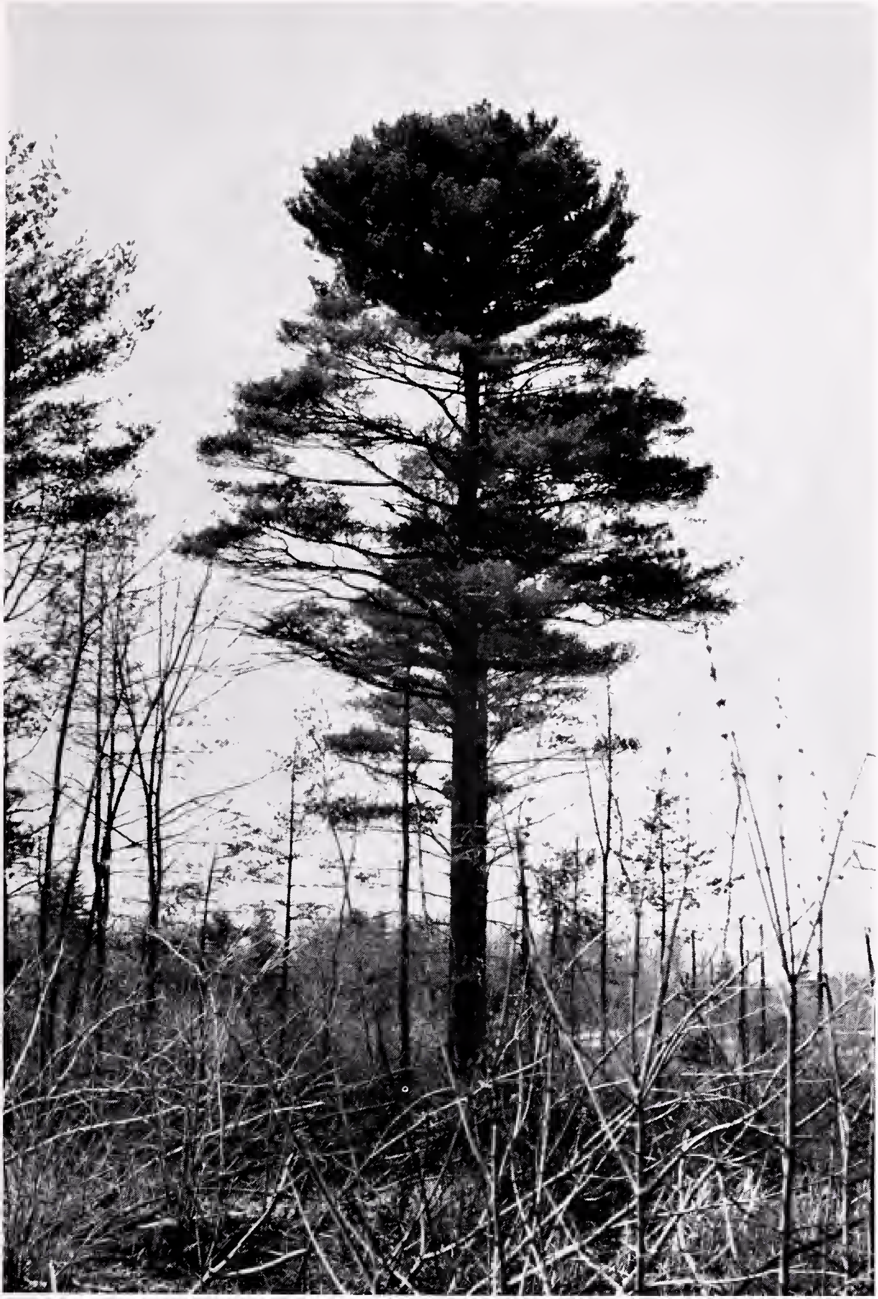

PLATE XIII

A massive witches'-broom comprising the entire crown of a white pine tree approximately 50 feet tall.

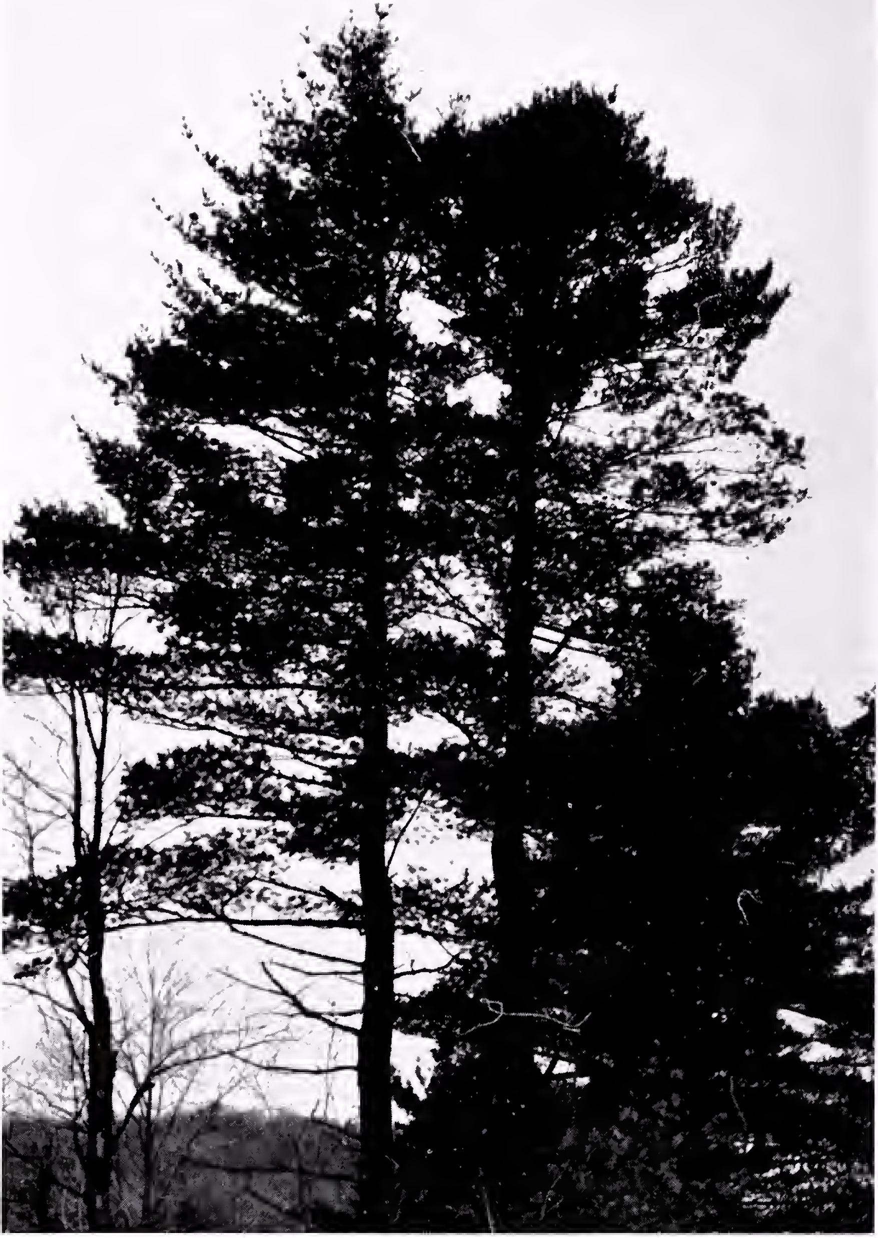

PLATE XIV

A terminal witches'-broom on eastern white pine. Its seeds have given rise to numerous dwarf plants.

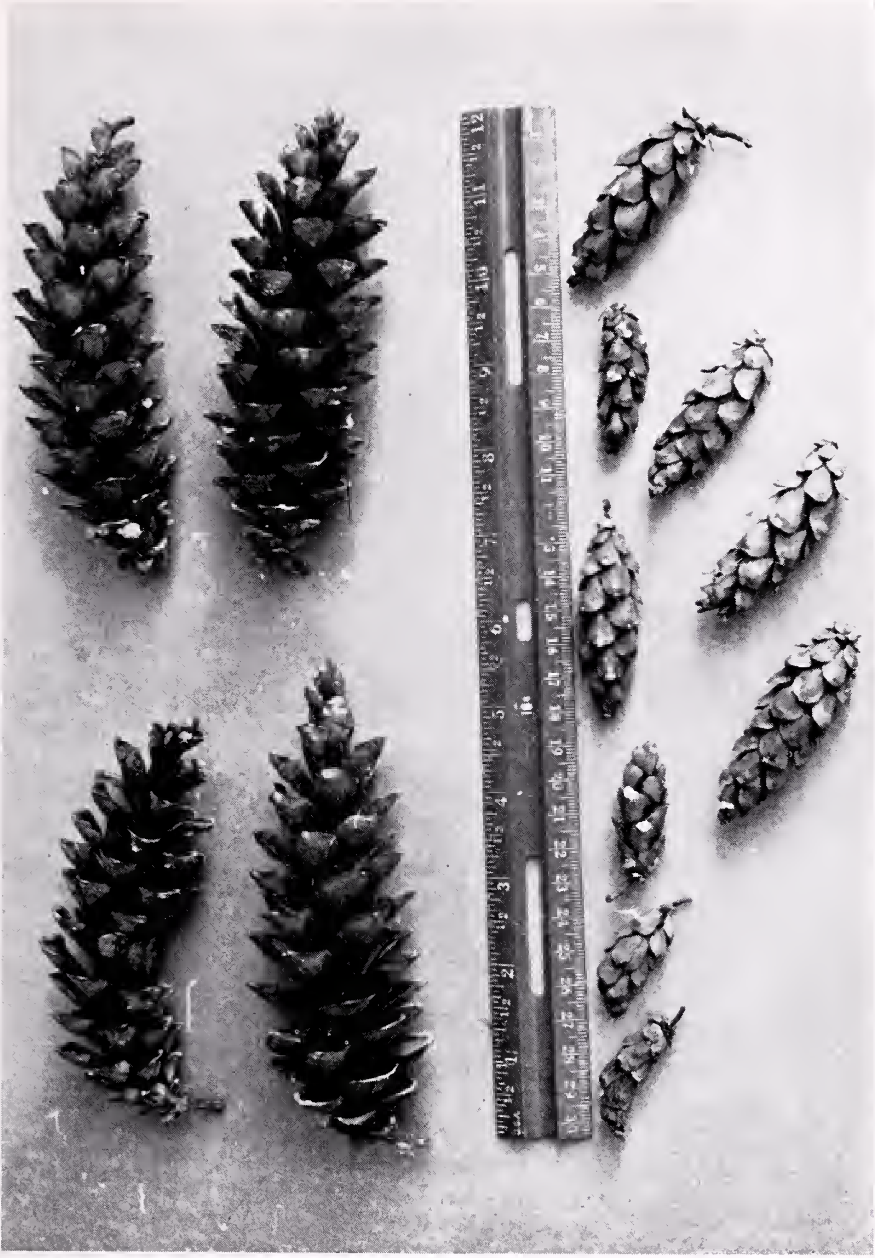

PLATE XV
Cones from a witches'-broom (right) showing the diversity of subnormal sizes as compared with normal white pine cones (left).

TABLE I

OBSERVATIONS — SEEDS AND SEEDLINGS FROM WITCHES'-BROOMS

Species	Arnold Arboretum Accession No.	Percentage of Germination	Percentage of Abnormal Segregates	Observations
Pinus banksiana	200–64	67	48	Abnormal seedlings have central trunks. Internodes are short, leading to midget plants with crowded branches. In some, side branch growth exceeds leader growth, resulting in plants that are broader than tall.
Pinus banksiana	1025–65	96	52	Dwarf form.
	1026–65	98	12	Normal form.
				Second generation witches'-broom seedlings (see text).
Pinus rigida	158–64	11	36	All have central trunks. Growth rates vary widely. Some plants are prostrate.
Pinus strobus	1198–63	59	48	Abnormal seedlings lack central leaders. Lateral branches have developed in cotyledon area of young seedlings, leading to multibranched, globe-shaped plants. Growth rates are variable.
	119–64	98	54	
	159–64	49	48	
	1143–64	Seeds not counted	57	
	1145–64	67	58	
Pinus strobus	1144–64	Seeds not counted	65	Smallest cones separated from lot 1143–64 and processed independently. This lot produced a higher ratio of dwarf seedlings than any other observed.
Pinus virginiana	1122–64	42	35	All seedlings had central trunks and showed no abnormality until they were about four inches tall. At this stage some leading shoots grew horizontally and later became pendulous. Still others bent over at ground level and became prostrate.

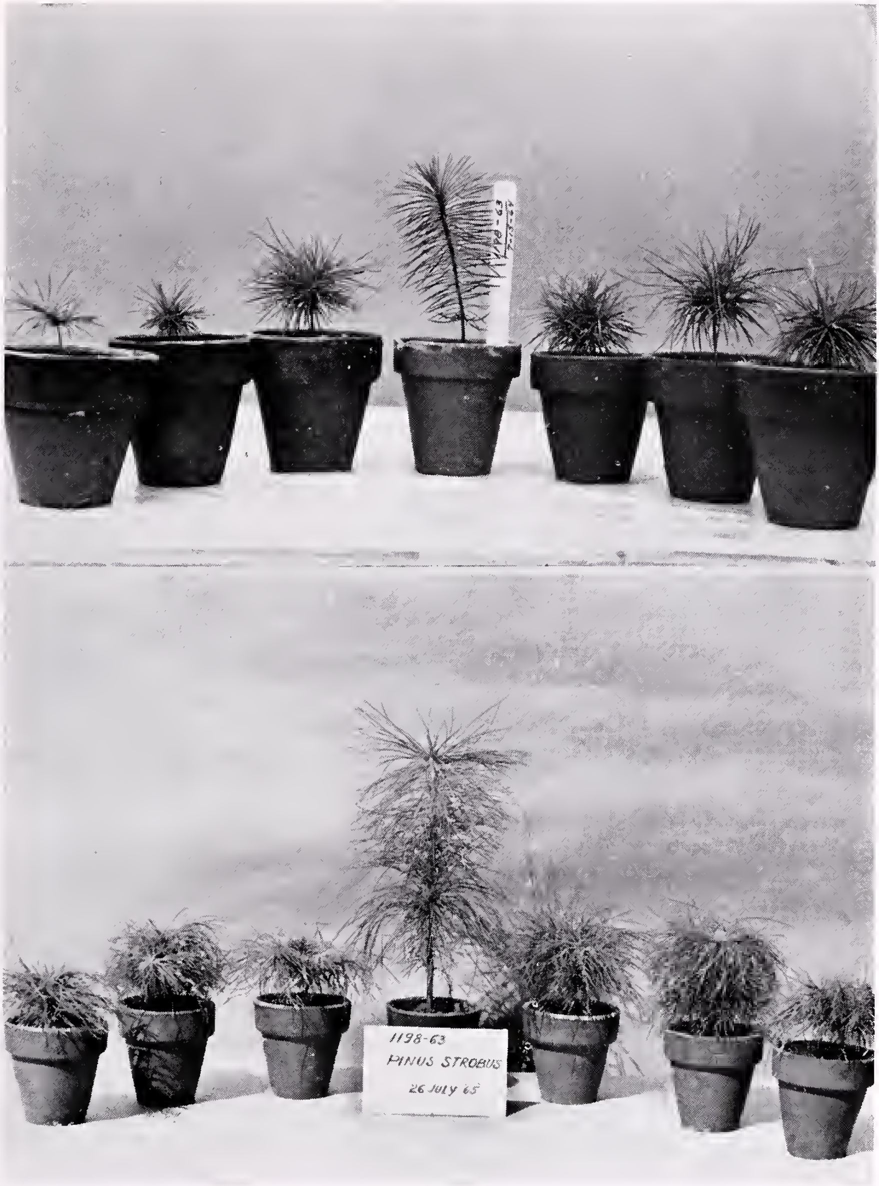

PLATE XVI

(Top) A selected sampling of white pine witches'-broom seedlings (1198–63, Table I). (Bottom) Seedlings from the same lot one year later.

A professional plant collector discovered the broom and the abnormal seedlings in October 1962. Some seedlings bore leaves about normal in size while others had leaves less than one inch long. The discovery of these abnormal pines illustrates one method by which dwarf conifers may originate spontaneously under natural conditions.

Seedlings from Witches'-broom Seeds

In 1933, two discussions of seedlings from fruiting witches'-brooms appeared in the German scientific literature. In the first, von Tubeuf[1] reported on his experiments in 1907 and 1930 with seeds from witches'-brooms of Norway Spruce (*Picea abies*). Two seedling lots in 1930 led to populations in which 27.7% and 38.5% of the seedlings showed the "bush-like" growth of witches'-brooms. In the second paper, Liese[2] discussed witches'-broom seedlings of pines and believed that the brooms originated from bud mutations. A number of seedling populations presently under observation at the Arnold Arboretum (Table I) tend to support this conclusion, for in a portion of each, abnormal characteristics are transmitted to the progeny.

A number of fruiting white pine witches'-brooms have been observed by the author during the past five years. Each had only female conelets, but bore them heavily every year, in contrast to the usual fruiting habit of white pine, in which lean and lush years occur. In years when cones have been scarce on trees in an area, weevils have concentrated on the more abundant cones of the brooms and have destroyed many seeds. Cones from these brooms did not open as white pine cones normally do, and each scale had to be pried open separately to extract the seeds. Such tedious procedure is compensated for by the increased latitude in time when seeds can be collected — in the Boston area, cones of white pine open and disperse their seeds in late August, but some witches'-broom cones still contained seeds when collected many weeks later.

Plate XVI (top) shows a selected sampling of white pine witches'-broom seedlings (1198-63, Table I). The seeds were collected on September 20, 1963, placed in cold stratification for 3 months, sown on December 20, and had germinated by January 3, 1964. Differences in the seedlings became readily apparent as soon as they had passed the cotyledon stage. Those considered normal (52%) developed central stems, while the other 48% produced lateral branches in the cotyledon area, were slow growing, and lacked central leaders. Adult leaf bundles had appeared on the dwarfs when this picture was made in July 1964, while the normal seedlings (center plant) still bore juvenile foliage. Plate XVI (bottom) pictures seedlings from the same lot one year later. At this stage the normal

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[1] K. von Tubeuf, "Das Problem der Hexenbesen," *Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz* (1933).

[2] J. Liese, "Vererbung der Hexenbesenbildung bei der Kiefer," *Zeitschrift fur Forst- und Jagdwesen* (Berlin, 1933).

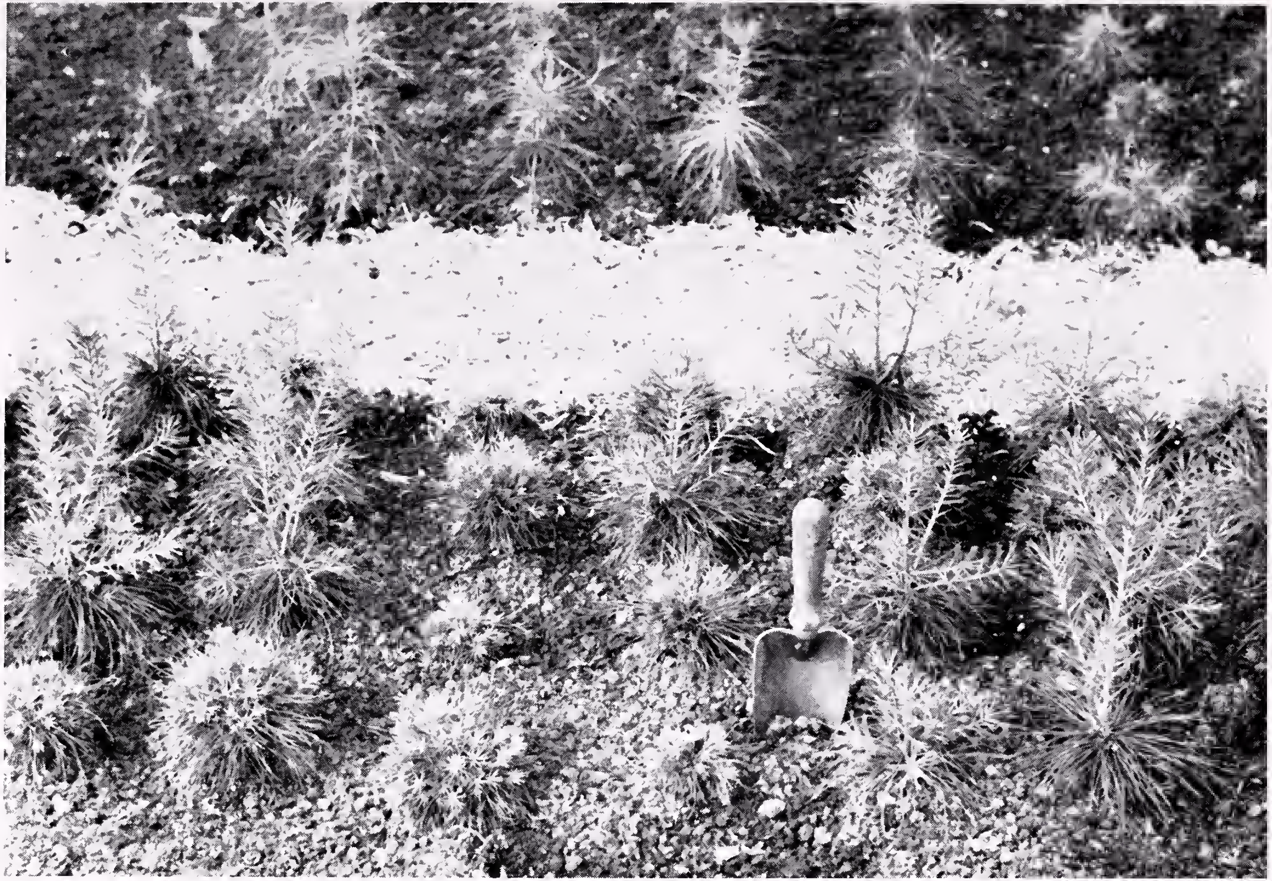

PLATE XVII

A white pine seedling lot (199–64, Table I) in a nursery bed. Normal plants and globe-shaped dwarfs of variable growth rate are present.

seedlings had continued upward growth while the dwarfs were globe-shaped. All other witches'-broom seedling lots of eastern white pine behaved similarly.

Plate XVII shows another white pine seedling lot (199–64) in a nursery bed. Normal plants and globe-shaped dwarfs of variable growth rate are present.

The characteristics of a group of jack pine (*Pinus banksiana*) witches'-broom seedlings (200–64) are described in Table I and shown in Plate XVIII (top). All have central trunks, but about half have short internodes resulting in midget plants with crowded branches. In some, lateral growth has exceeded upright growth, resulting in plants broader than tall.

A group of witches'-broom seedlings of Virginia pine (*Pinus virginiana*) (1122–64), described in Table I, is shown in Plate XVIII (bottom). All have central trunks and failed to show abnormality until about 4 inches tall. At this stage some leading shoots grew horizontally and later became pendulous. Still others bent over near ground level and became prostrate. A seedling population of *Pinus rigida* (158–64) behaved in a manner similar to *P. virginiana* — no distinct differences appeared until about a year and a half had elapsed. At that time the abnormal seedlings (36%) showed varying growth rates and some were prostrate.

Second Generation Witches'-broom Seedlings

In April 1965, two seed lots of jack pine (*Pinus banksiana*) were received from Mr. Albert G. Johnson, Associate Scientist, Department of Horticultural Science, University of Minnesota. He had collected seeds earlier from a jack pine witches'-broom at Gordon, Wisconsin, and from these had raised plants to fruiting size. Of four seedlings surviving in 1965, one was dwarfed and resembled the parent broom in form and leaf character. The other three were normal in form. Two lots of seeds sent to the Arnold Arboretum in 1965 consisted of 50 seeds (1025–65) from the dwarf form and 50 seeds (1026–65) from one of the normal trees. The character of seedlings grown from these two lots is given in Table I.

Progeny of Witches'-brooms Propagated Vegetatively

A number of plants propagated vegetatively from witches'-brooms are under observation at the Arnold Arboretum. Table II lists them and summarizes their present condition and characteristics.

Plate XIX (top) shows a dwarf multi-branched white pine of witches'-broom origin (315–63) propagated by grafting in March 1963 and photographed in April 1967. It is now 12 inches tall and 19 inches broad. Some well known dwarf conifers that originated as vegetative propagation of witches'-brooms, and the dates when they first appeared in the literature, are: *Picea abies* 'Maxwellii' (1874), *P. nigra* 'Hornibrookiana' (1932), *P. sylvestris* 'Beauvronensis' (1891), *P. abies* 'Tabulaeformis' (1890). These have maintained their characteristics through propagation and repropagation — they have withstood the test of time. It is probable that others will soon appear in the literature, for in the last

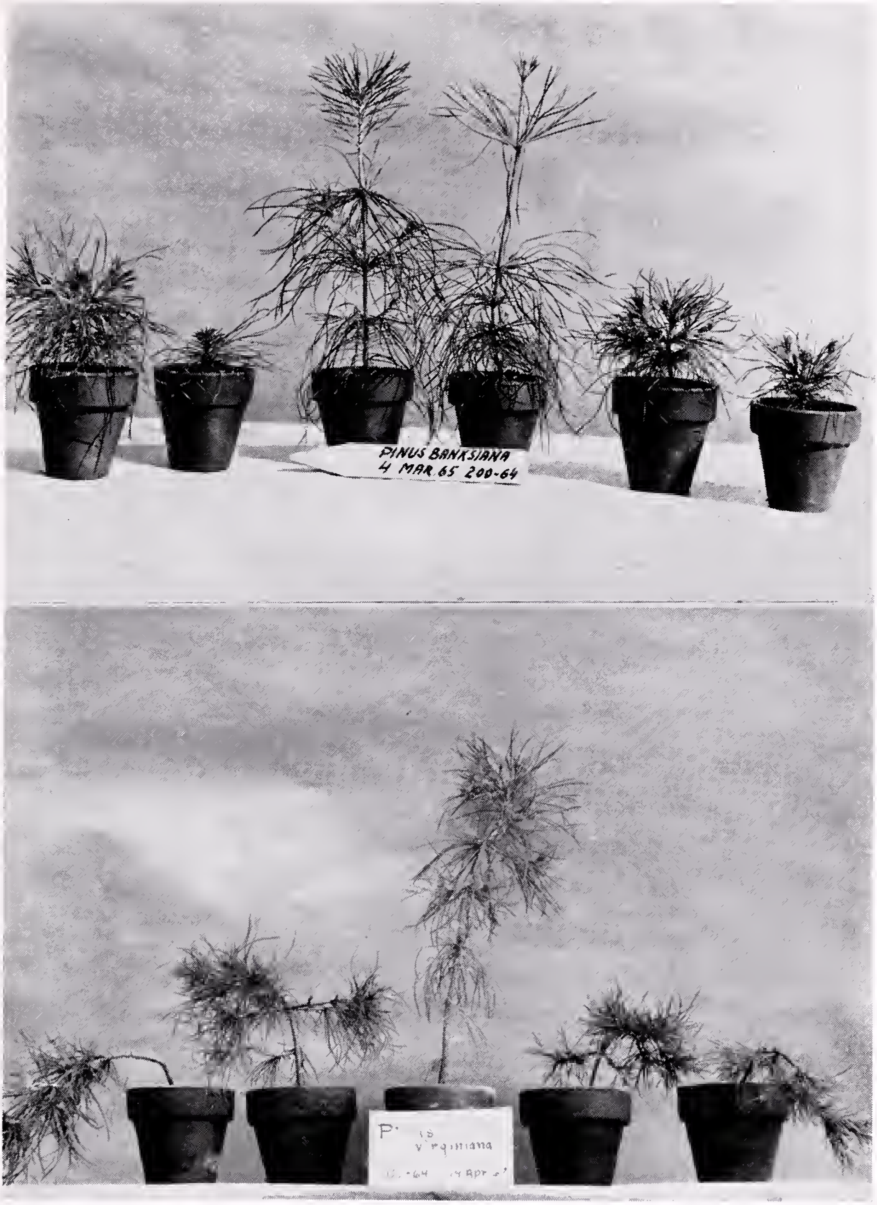

PLATE XVIII

(Top) A group of jack pine witches'-broom seedlings. (Bottom) A group of Virginia pine witches'-broom seedlings.

Table II

PROGENY OF WITCHES'-BROOMS PROPAGATED VEGETATIVELY

Species	Arnold Arboretum Accession No.	Method of Propagation	Observations
Abies balsamea	991–64	Rooted cuttings	Unhealthy in appearance, failed to survive.
Abies cephalonica	467–65	Grafted	Unhealthy, apparently diseased.
Abies concolor	908–65	Grafted	Unhealthy, apparently diseased.
Cedrus libani	249–65	Grafted	Grafts united and seemed healthy until understock was removed at which time they promptly failed. In 3 cases the understock was not removed and the scions have gone through several cycles of defoliation and foliation each year.
Larix laricina	681–63	Rooted cuttings	Failure of certain branches was continuous and plants petered out over a period of three years.
Picea glauca 'Conica'	1536–65	Rooted cuttings	Condition good.
Picea rubens	676–63	Rooted cuttings	Condition good.
Pinus resinosa	1205–65	Grafted	Multibranched, condition good.
Pinus strobus	313–63	Grafted	Multibranched, globe-shaped, condition good.
Pinus strobus	315–63	Grafted	Multibranched, globe-shaped, condition good,
Pinus strobus	380–65	Grafted	Broom had unnatural swellings, fissures, and resinous exudate on its branches. Propagations are pale in color and unthrifty.
Pinus strobus	487–65	Grafted	Multibranched, condition good.
Pinus strobus	1522–65	Grafted	Multibranched, condition good.
Pinus strobus	265–66	Grafted	Multibranched, condition good.
Tsuga canadensis	80–64	Grafted	Multibranched, condition good.

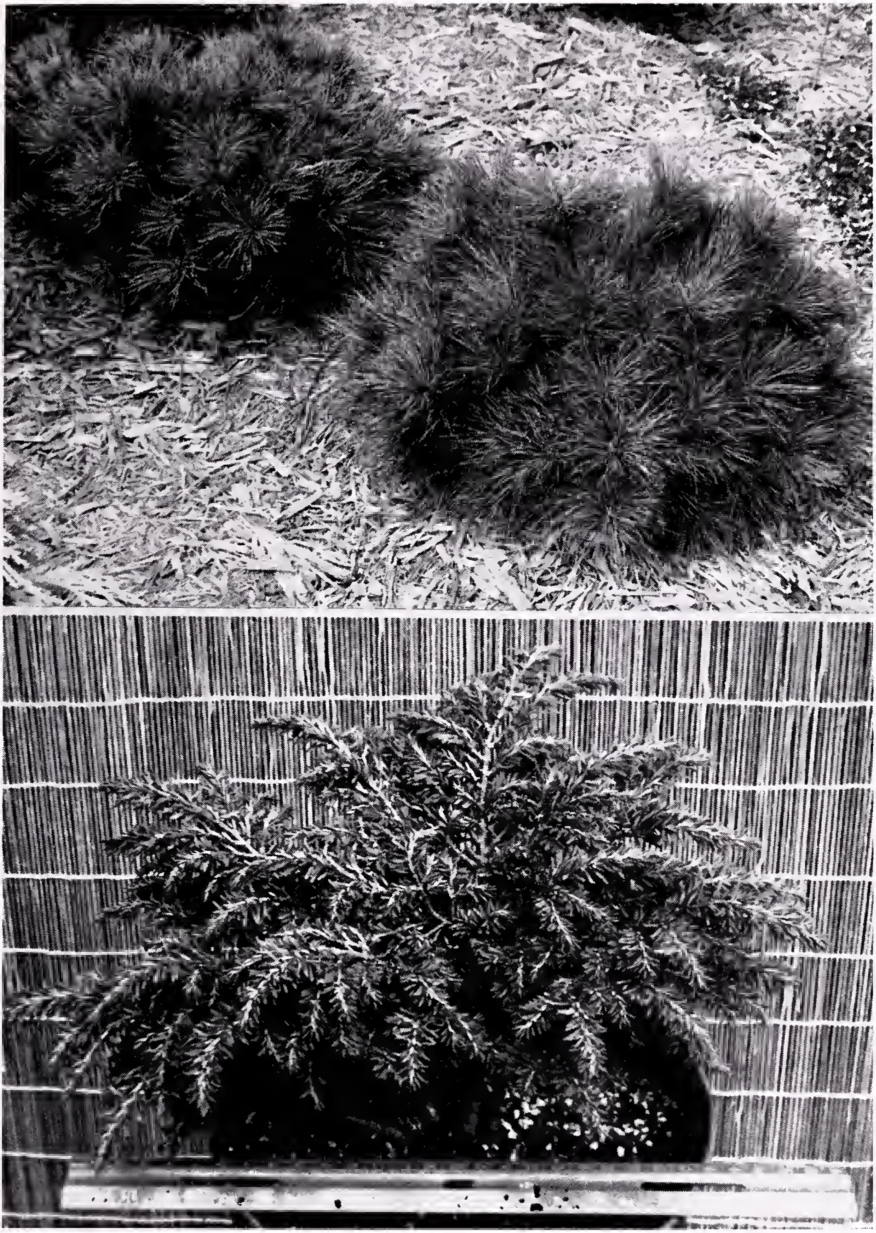

PLATE XIX

(Top) Dwarf multi-branched white pines of witches'-broom origin, propagated by grafting. (Bottom) Canada hemlock of witches'-broom origin propagated by grafting. Although over 150 Canada hemlock variants are present in the Arnold Arboretum this one appears to be distinct.

few years interest in witches'-broom propagation has expanded enormously.

A propagation of Canada hemlock (*Tsuga canadensis*) by grafting (80–64) is shown in Plate XIX (bottom). Although more than 150 Canada hemlock variants are present in the Arnold Arboretum, this one appears at present to be distinct from others in the collection.

Horticultural Significance of Witches'-broom Progeny

Increasing interest in dwarf and slow-growing conifers has given added significance to dwarf plants of witches'-broom origin. Those propagated vegetatively have retained characteristics of the brooms from which they originated, thereby leading to slow-growing forms with year-round interest. They are suitable for use in dwarf conifer collections, rock gardens, foundation designs, and situations where plants requiring little or no maintenance are desired. Seedlings from fruiting witches'-brooms have produced large numbers of dwarf and abnormal plants, including forms of prostrate habit suitable for planting over rocks and walls. Still other seedlings characterized by central stems, horizontal leaders, and short internodes quickly develop into miniature plants presenting an appearance of age, making them ideal subjects for bonsai.

As time passes, this increased interest in propagating plants from witches'-brooms will doubtless add greatly to the list of dwarf and unusual plants presently available for horticultural use.

If perchance a reader has knowledge of a fruiting witches'-broom of any conifer, a contribution of its seeds would be welcomed by the Arnold Arboretum to further this study.

Alfred J. Fordham

IDENTIFICATION OF UNKNOWN PLANTS

One of the functions of the Arnold Arboretum staff is identification of unknown plants for the public. Since the accuracy and completeness of an identification depends not only upon the competence of the person making it but also upon the adequacy of the sample provided, some suggestions on preparing samples for identification are offered here.

In plant identification, as in any scientific effort, the more information we have about the problem, the more likely we are to obtain a satisfactory solution. Frequently we receive a snippet of twig, perhaps 2 or 3 inches long, with a few leaves—and we are then asked to provide an accurate and complete identification. With luck, some staff member will be able to recognize it on sight to its *species* —and if it is unusually distinctive, to its *variety*. But it is almost impossible to identify such a scrap to its *cultivar* (horticultural variety).

There are about 250,000 different plant species in the world. In the United States and Canada there are probably about 20,000 species of plants in cultivation (and many cultivars of some of these). About 5,000 of these species are common in cultivation. An individual botanist or horticulturist can recognize at sight up to 3- or 4,000 species. In addition, he can recognize many more plants to their *genus* or *family*, and then determine the name of the individual plant with the help of plant keys. The point is that no one, no matter how studious, can be expected to identify at sight all of the 5,000 or so common garden plants, not to mention all of the others not usually found in cultivation.

Identification of unknown plants at an institution like the Arnold Arboretum ought to be a two-way street. The questioner ought to find out the name of the plant that he is interested in (and he often also wants to know where to obtain the plant and how to grow it). But the identifier ought to get something, too—he wants to learn something about the habits of the plant—its growth, its hardiness, its usefulness, or the nuisance that it may cause. He would also like to have a specimen of the plant to keep, to tie all this information together for future reference.

What Should Be Sent When You Want to Know the Name of a Plant?

1. **A piece of the plant.** Send a twig or small branch, at least 6 to 12 inches long, preferably with leaves. When possible include flowers and/or fruits. Sometimes it is impossible to obtain a complete specimen of a plant. If neither flowers nor fruit are available, send a good sample of leaves *and twig*. If leaves are gone but interesting fruits remain, send them—but be sure to include the twig to which they are attached.

2. **Notes on the plant.** Send information on the habit or shape of the plant; where it is growing; its flower and/or fruit color; fragrance of its leaves or flowers, if any; whether or not the fruits or leaves have been used for food or flavoring, and if so, a description of their flavor; and the source from which the plant was originally obtained. A sample form for recording this information is shown below.

3. **A color photograph, when possible.** A clear, sharp color photo of the more conspicuous features of the plant, e.g. flowers, fruit or overall shape, will often help in making an identification, especially if only an incomplete sample is available. This may be essential if you want a cultivar identified.

How Should You Prepare and Send a Sample for Identification?

In either of these two ways:

1. **Fresh specimens.** Place the sample in a plastic bag and seal tightly. Do not add water—the moisture in the sample will be enough to keep it fresh—excess water hastens decomposition. Place the bag in a strong cardboard box, or press between two sheets of cardboard, as suggested for dry specimens (below).

2. **Dried specimens.** Place the sample between 5 to 10 folded sheets of dry newspaper and press under 2 or 3 large books for several days. Then place the sample (in a single folded sheet of newspaper) between 2 sheets of cardboard and tie or tape securely to prevent damage from bending.

Gordon P. DeWolf, Jr.

YOUR NAME ______________________ DATE __________

YOUR ADDRESS ______________________ ZIP CODE ______

LOCATION OF PLANT (IF DIFFERENT FROM ABOVE ADDRESS)

____

DESCRIPTION OF PLANT: GROWTH HABIT ______________

HEIGHT ______________ FLOWER COLOR ______________

HABITAT (WET OR DRY, SUNNY OR SHADY ROCKY, ETC.) ______________

____

OTHER OBSERVATIONS ______________________________

no. 6,
p. 1

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ARNOLDIA

A continuation of the
Bulletin of Popular Information
of the Arnold Arboretum, Harvard University

Volume 27 JUNE 30, 1967 Number 6

PLANT HARDINESS ZONE MAPS

PLANT hardiness zone maps have been a valuable aid to those interested in predicting the adaptability of plants to specific climatic areas. Most are isotherm maps of geographical regions, based upon average annual minimum temperatures experienced at certain weather stations over some period of years. Many hardiness zone maps are available — some cover small areas such as individual states, while others encompass entire countries. Unfortunately, many do not agree in their numbering schemes — so zone numbers assigned to individual plant species cannot be used in referring to all of the existing maps. In most cases they can be related only to the map used in assigning them. The two most widely used in this country are the Arnold Arboretum hardiness map and the Plant Hardiness Zone Map prepared by the Agricultural Research Service, United States Department of Agriculture.

Arnold Arboretum Hardiness Maps

The original map prepared at the Arnold Arboretum was published in the first edition (1927) of *Manual of Cultivated Trees and Shrubs* by Alfred Rehder. In this map, the United States and southern Canada (except for southern Florida) were divided into 8 zones characterized by 5° F. differences in lowest monthly mean temperature.

A few years later, the prototype of the present Arnold Arboretum hardiness map was prepared by Donald Wyman. It included the entire United States and was first published in his book *Hedges, Screens and Windbreaks* in 1938. This map was based on average annual minimum temperatures for the years 1895 to 1935, as published in the *Atlas of American Agriculture*, U.S. Dept. of Agriculture, in 1936. A modification appeared in the second edition of Rehder's *Manual of Cultivated Trees and Shrubs* in 1940. In that book, the southernmost part of the United States was not included and much of Canada was added, in keeping with the Manual's scope.

The Arnold Arboretum Hardiness Zone Map in use since 1949 includes the entire United States (except for Alaska and Hawaii) and southern Canada. This was first published in Wyman's *Shrubs and Vines for American Gardens*, and republished in his books *Trees for American Gardens* (1951 and 1965), *The Arnold Arboretum Garden Book* (1954), *Ground Cover Plants* (1956), and *The Saturday Morning Gardener* (1962).

1967 Arnold Arboretum Hardiness Map

The Arnold Arboretum map has just been revised and appears in its latest form in the center fold of this publication.[1]

This 1967 map differs from the previous version only in that hardiness zone lines have been re-drawn to conform to more recent weather data. The zone numbering system is unchanged — so zone numbers applied to specific plants in Rehder's manual and other publications by the Arnold Arboretum staff can be used with the new map just as well as with its predecessor.

Plant Hardiness Zone Map, U.S. Department of Agriculture

This map was issued in 1960 as Miscellaneous Publication No. 814 of the Agricultural Research Service, United States Department of Agriculture. It contains uniform zones of 10° F., and sub-zones of 5° F. Since the Arnold Arboretum map uses zones of different ranges (5°, 10°, or 15° F.), discrepancies between the two are inevitable. Unfortunately for the casual user, these inconsistencies are small enough to be overlooked, and in several instances, writers have erroneously applied the hardiness zone designations of Rehder to the U.S.D.A. map. Table I shows the relationship between the two numbering systems.

Local Hardiness Zone Maps

More detailed plant hardiness zone maps have been prepared for certain states and localities. The total area covered by such maps is still rather small. Fortunately some detailed maps use the same zone numbering system as the larger, more general maps. A good example is a recently prepared hardiness zone map of the state of Vermont.[2] This map uses the same zone numbering system as the U.S. Department of Agriculture map, but is based upon a larger number of weather stations in Vermont, so zone lines have been drawn in more detail than in the larger map. As more areas are mapped in greater detail in this way, hardiness zone maps will become increasingly useful.

Additional copies of this map are available from the Arnold Arboretum at 10¢ each, postpaid.

[2] Hopp, R.J. and R.E. Lautzenheiser. 1966. Extreme winter temperatures in Vermont. University of Vermont Agricultural Experiment Station Bulletin 648, 19 pp.

HARDINE
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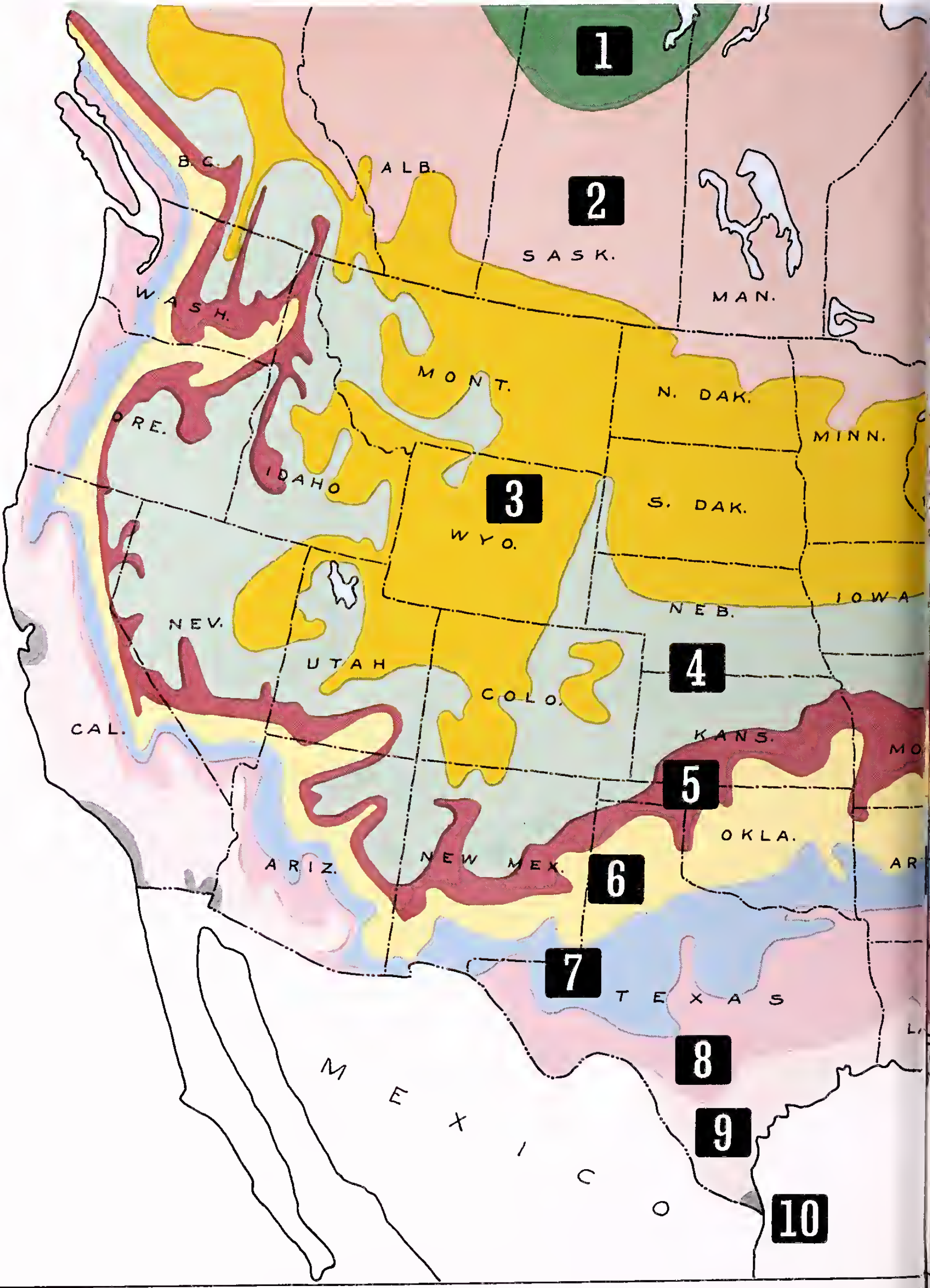
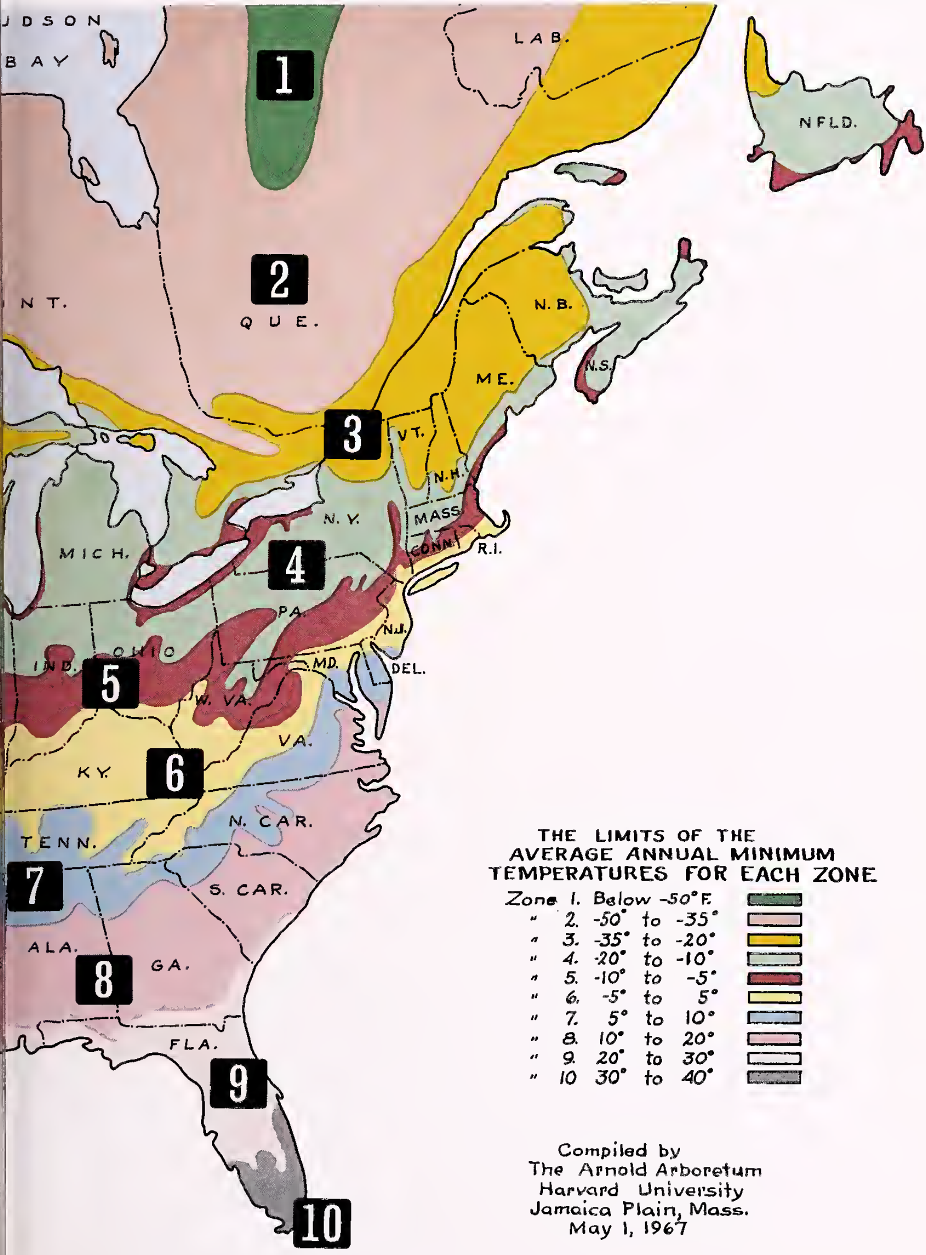
UNITED STATE



ZONES

and CANADA



THE LIMITS OF THE
AVERAGE ANNUAL MINIMUM
TEMPERATURES FOR EACH ZONE

Zone	1.	Below -50°F.			▬
"	2.	-50°	to	-35°	▬
"	3.	-35°	to	-20°	▬
"	4.	-20°	to	-10°	▬
"	5.	-10°	to	-5°	▬
"	6.	-5°	to	5°	▬
"	7.	5°	to	10°	▬
"	8.	10°	to	20°	▬
"	9.	20°	to	30°	▬
"	10	30°	to	40°	▬

Compiled by
The Arnold Arboretum
Harvard University
Jamaica Plain, Mass.
May 1, 1967

Table I

Arnold Arboretum Hardiness Zone	Range of Average Annual Minimum Temperature (°F)	United States Department of Agriculture Hardiness Zone
1	Below −50	1
2	−50 to −45	2a
	−45 to −40	2b
	−40 to −35	3a
3	−35 to −30	3b
	−30 to −25	4a
	−25 to −20	4b
4	−20 to −15	5a
	−15 to −10	5b
5	−10 to −5	6a
6	−5 to 0	6b
	0 to 5	7a
7	5 to 10	7b
8	10 to 15	8a
	15 to 20	8b
9	20 to 25	9a
	25 to 30	9b
10	30 to 35	10a
	35 to 40	10b

Canadian Plant Hardiness Map

The Canadian Plant Hardiness Map, released this year by the Canada Department of Agriculture, covers all but the far northern parts of Canada. This map represents a new approach in that it is an attempt to describe hardiness zones in terms of the whole complex of environmental factors that contribute to severity of climate, rather than in terms of a single factor such as average annual minimum temperature. To as great an extent as possible, actual observations of plant adaptability have played a part in describing hardiness zones.

Direct comparisons between this map and those prepared in the United States are not valid, because of the different criteria used in describing hardiness zones.

The Future

It appears that the business of preparing hardiness zone maps and assigning plants to their proper zones is still in the experimental stage. Hopefully, we may eventually see wide adoption of a single hardiness zone map for the United States, for North America, or even for the northern hemisphere. If this is some day accomplished, the problem of assigning realistic zone numbers to specific plants will still remain. The ability to match plants with zones over wide regions will be the ultimate test of any map, and many more careful observations will have to be made before this can be done with most of our present trees and shrubs. Meanwhile the existing maps will continue to be useful. But to use them most effectively we must recognize their differences and use published zone references only with the right map.

Donald Wyman
Harrison L. Flint

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ARNOLDIA

A continuation of the
Bulletin of Popular Information
of the Arnold Arboretum, Harvard University

Volume 27 JULY 28, 1967 Number 7

OUR DISAPPEARING OPPORTUNITIES[1]

Ladies and Gentlemen:

I welcome the opportunity of being the first speaker in this Parkland Conference and my theme which I shall keep coming back to is this: that the character and beauty which we strive to preserve in this city and Commonwealth too often have disappeared before we citizens ever knew that it was threatened.

The American elm is a New England character. It used to shade the oldest house; its wine-glass silhouette is a landmark in any meadow; its branches make a summer cloister of famous streets in Salem, or Williamstown, and with the lilac bush it is the last guardian of the deserted farm. Rightly it is called the Patriot Tree, for under its boughs treaties were signed with the Indians, Washington took command of his Army; George Whitefield, the evangelist, preached to thousands on Boston Common; and under it came the rushing embrace of the home-comings after Appomattox. The sight of an old elm makes you feel younger and, for the moment, surer that good things last.

A century ago in the Atlantic the "Autocrat of the Breakfast Table," Dr. Oliver Wendell Holmes, sent out a call for someone to do the biography and the photographs of the oldest elms in New England, and in time the book appeared with superb plates by Henry Brooks, and the text by Lorin L. Dame. This big folio entitled *Typical Elms and Other Trees of Massachusetts*[2] is a rarity today. Every tree in it was more than a century and a half old, and what beauties they were: elm, oak, ash, tupelo, and the great chestnuts which Thoreau used to measure with two-and-a-half spreads of his arms. Chief among them was the elm, known as the Great Tree; it was planted in the Common about 1640, and it suffered from its first major cavity a hundred years later; a tree dentist in 1740 cleaned out the rot, filled the cavity with "clay, and other substances," and then bandaged it — yes, bandaged it — with canvas. The big beauty lived on until February, 1876, for a total of 236 years, and when the winter gales finally destroyed it Bostonians rushed to the spot and took home slabs and cuttings for table-tops and chairs.

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[1] An address presented at the Parkland Conference, sponsored by the Trustees of Reservations, in Boston, May 24, 1967.

[2] Boston: Little, Brown, and Company. 1890.

The Dutch elm disease was not man made, nor was the blight which exterminated our chestnuts, but the fact that one of these splendid species is now extinct and the other dangerously threatened should make us more intent to preserve the good trees we have. But has it? Not that I can see. The elms at the southern extremity of the Boston Common are diseased and dying; they should be cut down and healthy ones planted in their place. In the Public Garden we have lost many of the rare trees planted there by Frederick Law Olmstead; the replacements are commonplace willows. On Commonwealth Avenue we should have a second growth to preserve the magnificence of the Mall when the elms there go. Whose responsibility is it to care for the life of our trees?

The beauty of our heritage and the skill with which we are planning for tomorrow make Boston one of the four most visually-exciting cities in the U.S., the other three being San Francisco, New York, and Washington. Let me signalize the things which have made this so, beginning with the Park Street Church, the most beautiful single building in the center of town, and the one which continually attracts the eye. Next, Saint-Gaudens's monument in memory of Colonel Robert Gould Shaw, unquestionably the finest of all our city monuments. The Boston Common, the most vital and historic city Park in the nation, and across from it the Public Garden at this moment with its regiments of tulips and fruit trees in blossom in its prime. The Bulfinch State House, and close by the whole splendid monument of Beacon Hill. Then the North End, so different with a warmth and style all its own, as is well seen on North Square; it is the oldest part of our city to be in continual residence, and we must thank the Bostonians of Italian heritage for giving it the good restaurants, the friendliness, and safe streets, full of children, which are its character today.

Go to the Arnold Arboretum when the azaleas and lilacs are ready; go some late afternoon to the Fenway for the vitality of the gardens and the vista of the Museum; and if you love trees as I do, seek out those two giant elms on Branch Street which must have been planted when the Mt. Vernon proprietors were building Federalist Boston, and which are, I believe, the two oldest elms in the city today.

Finally, go at any time of night or day to the Charles River Basin, the most satisfying modern concept in our city and one that has not yet been destroyed by the automobile.

High rise of glass and concrete can be built anywhere; it is these things I speak of which rank Boston with the three other cities I cited. And how do we compare?

How are we keeping things up? Look at the Park Street Church, for instance. Not long ago the ugly rumor reached me that the proprietors of the church were considering the possibility of an eight-floor office building erected so close to the church that it would cover the rear portion. This is one of those disappearing acts that could happen before any of us were the wiser, and what a shame it would be! Or consider the Shaw Monument directly facing the State House, the Monument which should have such significance in our struggle for civil rights, the Monument which more tourists look at than any other in the city. For fourteen months it has remained in disgraceful condition, the figures streaked and defaced, the sword in Colonel Shaw's hand twisted and broken away by vandals. The same apes have torn the sword from Washington's monument in the Garden, and nobody gives a damn! I fail to understand why Boston takes such little pride in its best things — why it is not the responsibility of someone to restore our elegance. Our streets, whether in the Back Bay or on Beacon Hill, are so filthy with papers and beer cans that I should be ashamed to compare them with the residential streets Mayor John Lindsay has cleaned up in New York. As for the pollution of our nearest water, you only have to *smell* the Charles to know how foully we compare with Washington in that respect. The beauty of Boston Harbor was once known from here to Shanghai. If that shambles can be restored by Mr. Pei and Edward Logue,[3] we shall be deeply in their debt.

But what about the canopy overhead? By any measurement our air ranks Boston as one of the ten dirtiest cities in the nation. Isn't it a luxury to talk about preserving the beauty and character of the city when the air we breathe, the milk and water we drink, the land we love is as polluted as it is in this Commonwealth? The problem of pollution nation-wide is appalling, and the worst thing about it is that it is all man-made, made right here in the U.S. We are all to blame. The pollution from our automobile exhausts and factory chimneys, the industrial waste which fouls up our streams, the accumulated lethal acids which run off the land into our ponds and lakes, for these we have only ourselves to blame.

It sometimes seems to me as if our scientists worked in hermetically sealed cells intent on one-half of an equation and never counting the cost. Having perfected pesticides which could be dusted on our crops and DDT sprays which might bring momentary protection to our trees, it seems never to have occurred to chemists that what they were pouring over the land and forest could not be dissolved by water and would grow more lethal in its poisoning as it passed through each living organism. One wonders if the sludge now accumulating in Lake Erie will grow to the point where even ice-breakers can no longer penetrate it.

The best we can do about pollution locally is to join up into teams of vigilantes with two objectives in mind: to clean up and protect the neighborhood for which we are responsible, and to set aside in our own domain more of the open places and wet lands, more of the woods, and what the English call the "green lungs" which our grandchildren must have in the future. This was the original and driving purpose of the Trustees of Reservations; it is something that the community can do better than the state, and indeed, better than Washington, unless of course the project proves to be as large as the Cape Cod National Seashore Park.

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[3] Respectively, Mr. I. M. Pei of I. M. Pei and Associates, Architects, and Mr. Edward J. Logue, Development Administrator, Boston Redevelopment Authority.

I think we should celebrate those communities which are taking the initiative. I think that in January the Governor ought to cite each community which has carried to completion a major project in Conservation. High on any list at this moment would be the town of Dennis which at a recent town meeting voted $652,000 with which to purchase 1700 acres adjoining the town; 1700 acres of beach, uplands, and salt marsh taken out of reach of hit-and-run contractors, to be enjoyed in perpetuity by the people. Where can you do better than that?

I think the towns of Lincoln and Concord should be cited for their vigilance in zoning, for protection of their trees, and taking such pride in the health of their marshes and wetlands. I think we should cite Bedford for the long, patient work they have done in cleaning up their share of the Concord River. Credit should go to Sudbury for its unique Garden-in-the-Woods, and for those who have built up the quarter of a million dollars which will fortify it for the future. And to Salem great credit for preserving the glory of Chestnut Street.

Now coming back to Boston, wouldn't it be wonderful if the powers that be in the State House could be persuaded to invest in the depollution of just one famous Massachusetts river? It might be the Charles; it might be the Concord; it might be as ambitious an undertaking as the Merrimack. The Commonwealth of Pennsylvania was not afraid to clean up, to depollute miles and miles of the upper reaches of the Schuylkill. Why should we sit on our hands?

A famous Canadian and a bold conservationist, Roderick Haig-Brown, has proposed that all existing pollution of air, land, or water should be taxed in proportion to the demand it makes upon the resource. "All pollution," he says, "is the use of public property for private profit. It can be most accurately measured at its source and it should be taxed." Well, why not? Too often the attitude of the authorities is how much pollution can we get by with short of causing a disaster; how much of the cost of industry or settlement can we shove forward to be paid by the next generation. But if we had a pollution tax that could be graduated so as to insure the maximum elimination over a period of years, what a God-send it would be.

EDWARD WEEKS, *Editor*
Atlantic Monthly Press

Vol. 27, no. 8
p. 2

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OCT 2 1967
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BOTANICAL GARDEN

ARNOLDIA

A continuation of the
BULLETIN OF POPULAR INFORMATION
of the Arnold Arboretum, Harvard University

VOLUME 27 AUGUST 25, 1967 NUMBER 8

MORE PLANT REGISTRATIONS

THE Arnold Arboretum has been appointed the International Registration Authority for several woody plant genera and the National Registration Authority for certain other genera (*Arnoldia*, Vol. 23, No. 5, May 31, 1963). At the last International Horticultural Congress the Arnold Arboretum was also duly appointed the International Registration Authority for *Weigela*. The Arthur Hoyt Scott Foundation of Swarthmore College, Swarthmore, Pennsylvania is the International Registration Authority for *Syringa*. Plants that have been registered by these two registration authorities since the last listing in *Arnoldia* on April 29, 1966 (Vol. 26, No. 3) are included in this list. The most recent publication dealing with plant registration in general, both in America and abroad, is *American Association of Botanical Gardens and Arboretums Quarterly Newsletter* No. 64 (pp. 1–44), October 1965.

Cornus florida 'Pygmy'

A chance seedling found in Winchester, Tennessee about 1957 and introduced by Leon Hawkersmith & Sons Nursery of Winchester. It has been noted briefly in their catalogue of 1962 and the catalogue of the Tennessee Valley Nursery in 1965. In the words of Leon Hawkersmith, " 'Pygmy' is a dwarf white dogwood which was found at Riverside Nursery. At eight years of age, the plant is approximately four feet high. It produces an abundance of small 1½ inch white bracts which overlap."

Cornus florida 'Springtime'

The parent tree was noted in Spring Grove Cemetery in 1957 by Mr. E. C. Kern of Wyoming, Ohio, who introduced it in 1960. "This cultivar sets bloom buds at an early age, has "flowers" up to five inches in diameter, has a wide-spreading growth habit. The side branches over-grow the central leader. In the fall, the undersides of the leaves turn a distinctive purplish color."

Euonymus europaeus 'Red Cap'

A seedling, first observed in 1952 in a lot of seedlings of *Euonymus europaeus* from an isolated plant at the North Platte Experiment Station of the University of Nebraska at North Platte, Nebraska. The originator and introducer is listed as the University of Nebraska, Lincoln, Nebraska. The plant was selected in 1956 and commercially introduced in 1967. It is not patented. Professor Glenn Viehmeyer of the North Platte Experiment Station states that it "fruits more heavily and the fruits have a deeper color than the norm of the species. It is hardy throughout Nebraska and South Dakota," Zones 3 and 4, and will grow on "all except waterlogged soils."

Fagus sylvatica 'Cockleshell'

A sport of *Fagus sylvatica* 'Rotundifolia' first observed by Messrs. Hillier & Sons in the Eastleigh Nursery in Southampton, England in 1959. It was first described in an article by C. R. Lancaster in the *Gardeners Chronicle* of October 26, 1966 (Vol. 160, No. 17, p. 13). It bears small rounded leaves only about half the size of those of 'Rotundifolia' and it differs further from 'Rotundifolia' "in its more compact habit, the leaves smaller, neater and more congested on the short, spur-like branches." Its present height is 10–12 ft., and it resembles a Lombardy Poplar in habit.

Forsythia ovata 'French's Florence'

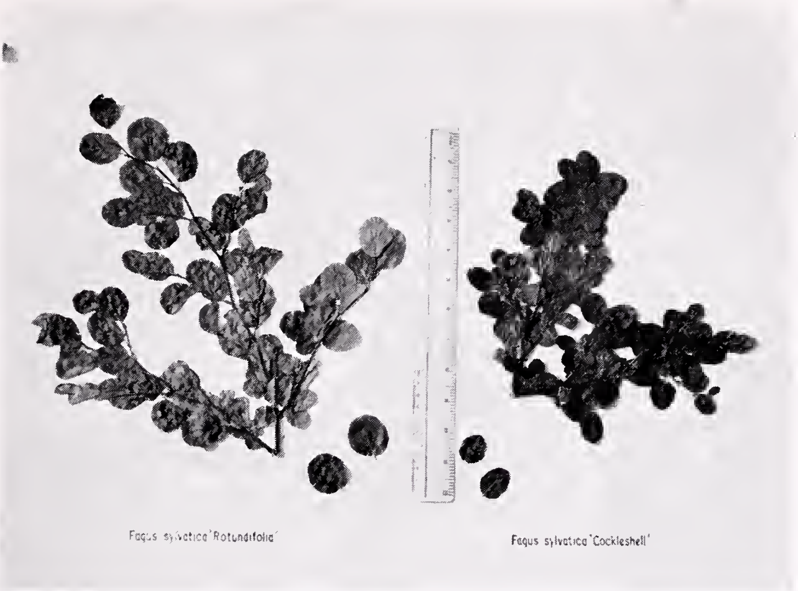
A 5-foot shrub originating as a seedling of *Forsythia ovata*, from seeds originally obtained from the Arnold Arboretum in the 1920's, at French's Nursery, West Lebanon, N.H., and first noticed by Florence K. French. It first flowered in 1930 and was commercially introduced in 1940. In the words of Mr. Kendall W. French, the introducer, it "has small flower buds and smaller, lighter flowers than *F. ovata* and grows about 5 feet high. It has flowered every year since 1930 in West Lebanon, N.H.", even in years when flower buds of other plants of *F. ovata* were winter-killed. This would be in the warmer parts of Hardiness Zone 3.

Juniperus horizontalis 'Watnong'

Mr. Donald P. Smith of Watnong Nursery, Morris Plains, N.J. sent in this form of the Horizontal Juniper for registration. It is a seedling originating about 1955, and apparently first fruited in 1962, when it was selected. The Watnong Nursery has had it in commercial propagation since 1963. "It is a female form that berries well. A vigorous grower with richer winter and summer color than other *J. horizontalis* forms. It forms a smooth carpet, never over 4 inches tall." It has been grown successfully in Zones 4 through 8.

Kalmia latifolia 'Bettina'

A mountain-laurel first observed in bloom at the National Arboretum, Wash-



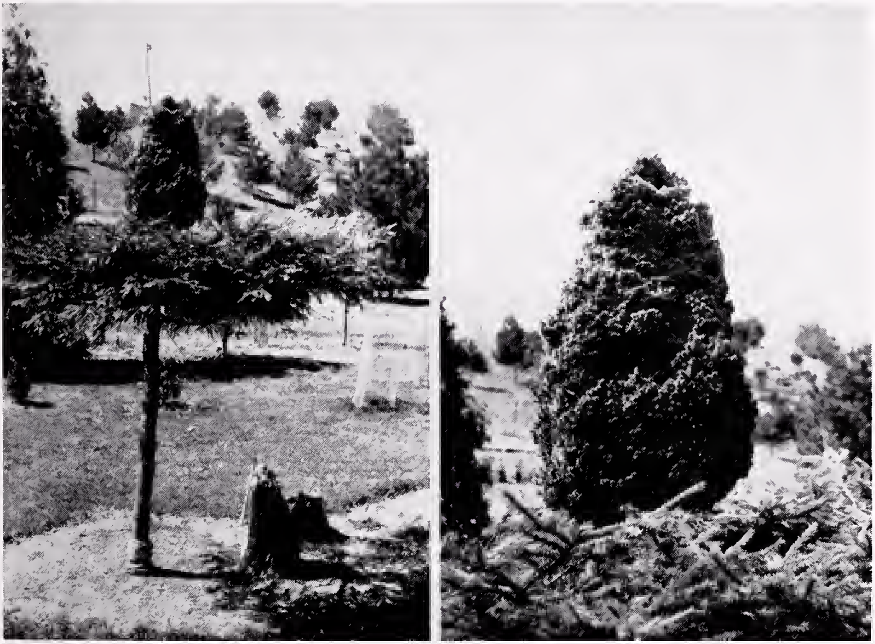


PLATE XX

(Top) *Fagus sylvatica* 'Cockleshell' bears small rounded leaves only about half the size of those of *F. sylvatica* 'Rotundifolia', and grows more compactly than the latter.

(Bottom) *Picea abies* 'Bennett's Miniature' originated as a densely compact, pyramidal witches'-broom about 30 inches tall at the top of a 10-foot tree of *Picea abies.*

ington, D.C., in the 1950's, and named, described and registered by Dr. T.R. Dudley, Research Botanist of that institution and named after Dr. Dudley's wife. In the words of Dr. Dudley, the "flowers are campanulate-urceolate, deep purplish pink (7.5 RP 6/12 on Nickerson Color Fan)—never open widely—inflorescences dense, bearing up to 100 flowers each." It will be fully described in the July 1967 issue of *American Horticulture Magazine.*

Koelreuteria paniculata 'September'

A seedling of unknown origin, approximately 25 years old, originated at Bloomington, Indiana where it was discovered in 1960 by Indiana University and registered by Prof. J. C. McDaniel of the University of Illinois. It was introduced commercially in 1967. Prof. McDaniel notes: "Flowering occurs consistently about 2 months later than in typical *K. paniculata*, or in late August to early September in Bloomington, Indiana and at Washington, D.C." The original tree is the most westerly of 3 trees southwest of the President's House at Indiana University.

Philadelphus 'Miniature Snowflake'

A shrub and sport of *Philadelphus* 'Minnesota Snowflake', first observed about 1954 and propagated in 1956. It originated in the J. V. Bailey Nurseries, St. Paul, Minn., and was introduced by this firm. It "attains height and width of about 2 feet. It has unusually clean and glossy foliage and very fragrant double white flowers similar to those of 'Minnesota Snowflake'. Hardy in St. Paul in Zone 4." Apparently it grows best in good loam but is quite adaptable.

Picea abies 'Bennett's Miniature'

A dwarf variety of the Norway Spruce, discovered at Princeton, W. Virginia in 1964 and introduced by Wm. M. Bennett of Christiansburg, Virginia. The original is a densely compact, pyramidal witches'-broom about 30 inches tall at the top of a 10-foot tree of *Picea abies* and apparently over 20 years old. Mr. Bennett writes "The annual growth averages approximately one half inch. The leaves are about $\frac{1}{4}$ inch in length, compact, and dark green in color. The overall effect is much tighter and more compact than any other dwarf or miniature Norway Spruce I have seen. Difficult to root but it has been grafted successfully for the past two years."

Pieris japonica grandiflora 'Purity'

K. Wada of Hakoneya Nurseries, P.O. Box 295, Yokohama, Japan, writes in the *Journal of the Royal Horticultural Society* (Vol. 92, pp. 26–28, 1967): "It is doubtful whether this plant belongs to *P. japonica* or *P. taiwanensis*. The origin of 'Purity' is a mystery. It is very probable that it is a very important natural sport. It has very large pure white flowers, so large and so heavy that they weigh down the trusses which otherwise would be held upright."

Pieris japonica rosea 'Daisen'

This has been described by K. Wada in the *Journal of the Royal Horticultural Society* (Vol. 92, pp. 26–28, 1967) as *Pieris japonica rosea* Daisen Form. It is not clear whether he intended this as a cultivar since no quotes were included in the text, but if he did, to conform to the rules set up in the *International Code of Nomenclature for Cultivated Plants* (1961) the name should be *Pieris japonica rosea* 'Daisen'. K. Wada writes "In Mount Daisen (Japan) a plant with deep pink coloured flowers was found and this plant has flowers that are almost red at opening, and becoming pink until they fade. The flowers are deeper pink in colour when the plant is kept in a cool place, without much strong direct sunshine. Under full sun the flowers fade. This Daisen form makes a very well shaped plant with plenty of beautiful leaves." It is not clear if this is in cultivation.

Pieris japonica rubra 'Christmas Cheer'

This has been described by K. Wada in the *Journal of the Royal Horticultural Society* (Vol. 92, pp. 26–28, 1967): "In our batch of seedlings from open-pollinated seeds of the Pink Pieris gathered from different sources, a very deep rose or almost red flower was obtained. This has been named *P. japonica rubra* 'Christmas Cheer'. From the appearance of this outstanding cultivar, *P. japonica* shows promise of reviving its old fame. This new form is so striking and so outstanding and rivals in beauty the modern greenhouse plants. It blooms earlier than regular *P. japonica*, in the earlier part of March, at the same time as *Rhododendron mucronulatum* or *Cyclamen coum*, and its flowers are highly frost-resistant. As it blooms so early the flowers are often covered with snow but they come through without suffering. It blooms extremely freely at the nursery stage. Moreover, the flowers are deep rose and give highlights to winter gardens. As a pot plant it is splendid and compares favourably with pot-grown azaleas. In florist shops many of the Lily-of-the-Valley-like trusses, attractive deep rose in colour, cannot fail to attract the general public. No doubt, this new *Pieris* is a grand addition to the spring pot-grown plants as well as to garden plants."

Pinus strobus 'Bennett's Contorted'

A clone of *Pinus strobus* originated at Blacksburg, Va. and noted in 1966, found by Wm. M. Bennett of Christiansburg, Virginia. It is about 10 years old. Mr. Bennett has compared it with *P. strobus* 'Contorta', 'Prostrata' and 'Pendula' and he states it is different from all three. The contorted branching structure appears to result from a 180° change in directional growth from vertical to completely pendulous in alternate years. Staking is not required.

Syringa

The following lilac names have been listed as registered by Dr. John C. Wister in the April 1967 issue of *Arboretum and Botanical Garden Bulletin* (Vol. 1, No. 2, pp. 19–20), the last 5 being merely listed with no description:

‘Miss Canada’
‘Lucelle’
‘Pom’
‘Redbud’
‘Alexander’s Advance’
‘Alexander’s Aristocrat’
‘Alexander’s Pink’
‘Mrs. J. Herbert Alexander’
‘Superba’

Ulmus × elegantissima ‘Jacqueline Hillier’

A seedling elm of unknown origin first observed in 1965 in a private garden in Selly Park, Birmingham, England. It was introduced by Hillier & Sons, Winchester, England. Mr. C. Roy Lancaster of that firm notes that it is “a small tree or suckering shrub with densely hairy twigs and small neat leaves. The young shoots are olive green, tinged with brown on the exposed surface conspicuously brown pubescent. The buds are minute, 1–2 mm., ovate, pale brown. The leaves are elliptic to oblong-elliptic, acuminate; rounded at the base, doubly serrate, sessile or nearly so (petioles 1 mm.), 25–27 mm. long × 15–16 mm. across. The upper surface is dark green, scabrid with short hairs. Lower surface paler and scabrid.” It was growing originally on a heavy clay soil, but like the species is adaptable to chalk soils, definitely hardy in the British Isles.

Weigela ‘Centennial’

Probably a clone of *Weigela florida*, this is a seedling of *Weigela* ‘Dropmore Pink’ probably crossed with *W.* ‘Profusion’. It originated at the Experimental Farm in Ottawa, Canada about 1953 and first flowered in 1955. It was named by W. A. Cumming, Research Officer, Ornamental Horticulture, Experimental Farm, Research Branch, Canada Department of Agriculture, Morden, Manitoba, and will be released for commercial propagation by that organization in 1967. According to Mr. Cumming it is “hardier than all popular cultivars tested at Morden with the exception of ‘Dropmore Pink’ from which it may be distinguished by its deeper erythrite red flowers.” It is listed as hardy in Zone 3 of the Arnold Arboretum Hardiness Map, and will tolerate slightly alkaline soils at least to a pH of 7.5.

A few other plants which were named several years ago have been recently registered (June 1967) by M. Van Rensselaer, Director, Saratoga Horticultural Foundation, Saratoga, California. Description of each can be found in the *Journal of the California Horticultural Society*, in the references mentioned:

Arctostaphylos densiflora ‘Howard McMinn’	Vol. XVIII, pp. 8–9, January 1957.
Ceanothus × ‘Joyce Coulter’	Vol. XXVI, p. 83, July 1965
Ceanothus × ‘Julia Phelps’	Vol. XIII, p. 20, January 1952.
Ceanothus × ‘Mills Glory’	Vol. XII, pp. 13–15, January 1951.
Ceanothus × ‘Roy Hartman’	Vol. XVII, pp. 145–146, October 1956.
Garrya elliptica ‘James Roof’	Vol. XXIII, pp. 80–82, April 1962.
Ginkgo biloba ‘Autumn Gold’	Vol. XVII, pp. 98–99, July 1956.

Donald Wyman

DR. PAUL D. SORENSEN
APPOINTED ASSISTANT HORTICULTURAL TAXONOMIST AT ARNOLD ARBORETUM

Dr. Paul D. Sorensen was appointed Assistant Horticultural Taxonomist at the Arnold Arboretum effective July 1, 1967. He received his B.A. degree from the University of Iowa in 1962 with a major in French but specialized in plant taxonomy for his M.S. in Botany in 1966 and his Ph.D. degree in 1967. He has taught botany and especially plant taxonomy as an assistant in several courses within the University of Iowa, the Extension Service in Adult Education and during the summer sessions. He also served as an assistant curator in the herbarium of the University of Iowa from 1964 to 1967.

During the summers of 1965 and 1966 he assisted Dr. T. E. Melchert in a botanical foray in Mexico and Guatemala with the special goal of collecting information on wild species of *Dahlia* and their contribution to this genus of cultivated plants. His thesis was on the systematics of the genus *Dahlia* and he brings much of this research material to Jamaica Plain for further studies of this important group of plants.

Through the areas of Iowa and Wisconsin the preservation of natural areas receives much more attention than do the problems of conservation in New England. Dr. Sorensen has an active interest in the use of natural areas as "living museums" and his interest in local floras can be associated with his earlier studies on the native vegetation of Iowa and Wisconsin.

Dr. Sorensen is a member of the International Association of Plant Taxonomists, the American Society of Plant Taxonomists, the American Institute of Biological Sciences, the Society of Sigma Xi, the Botanical Society of America, the Iowa Academy of Science and the Nature Conservancy. Dr. and Mrs. Sorensen and their three children will live in Jamaica Plain.

MRS. LAZELLA SCHWARTEN RETIRES AS LIBRARIAN OF THE ARNOLD ARBORETUM

Mrs. Lazella Schwarten retired July 1, 1967 as Librarian of the Arnold Arboretum, a post she had held since 1944. Mrs. Schwarten was invited to join the Arnold Arboretum staff by Dr. E. D. Merrill in 1944. She had begun her professional career in 1931 at the New York Botanical Garden where she had also worked with Dr. Merrill. While at New York, Mrs. Schwarten began work she was to continue throughout her appointments at Harvard, which served to relate closely the libraries and efforts of the two institutions in contributions of value to the botanical field. Working with Dr. Harold Rickett at New York, Mrs. Schwarten began the compilation of a standard list of abbreviations of botanical titles. This was published in 1947 in the *Bulletin of the Torrey Botanical Club.* An appendix was compiled and issued in 1961 and together these works are fundamental in the proper uniform and convenient citation of botanical periodicals and are used throughout the world.

Beginning in 1947, Mrs. Schwarten also served as compiler or co-compiler of the Index to American Botanical Literature which is issued in the *Bulletin of the Torrey Botanical Club.* During the organization and development of the American Society of Plant Taxonomists, Mrs. Schwarten worked closely with the late Dr. Wendell Camp in placing this important index to botanical literature in the hands of American taxonomists. She serves still as a collaborating compiler of this valuable tool which can be prepared only in a comprehensive library such as that of the New York Botanical Garden or of the botanical institutions at Harvard.

In 1958, Mrs. Schwarten was asked to head the combined libraries of the Arnold Arboretum and the Gray Herbarium in Cambridge. She has been responsible for the major task of combining the libraries in Cambridge, and of organizing a library for horticultural research and reference in Jamaica Plain. These two libraries, combined, are considered among the most complete in the Western hemisphere and certainly the most readily usable to botanists. A particular feature of these libraries developed by Mrs. Schwarten, with the influence of Professor Alfred Rehder strongly evident, is the extensive section of monographs and pamphlets classified according to families in the same sequence as the herbarium.

No bald statement of factual information communicates the role of Mrs. Schwarten as a person. In her years of service as Librarian of the Arnold Arboretum, she dispensed a vast amount of helpful information to students, staff and to visitors seeking her help. In fact, her most characteristic expression "May I help you" was truly and sincerely an invitation to say "yes". She was a friend to everyone who came to her for help. The library of the Arnold Arboretum will forever bear her mark.

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ARNOLDIA

A continuation of the
BULLETIN OF POPULAR INFORMATION
of the Arnold Arboretum, Harvard University

VOLUME 27 SEPTEMBER 8, 1967 NUMBER 9

SEPTEMBER BLOOM

There comes a time between mid-summer flowers
and autumn leaves
when color in trees and shrubs is hard to find.
In New England this time is September.

BUT careful selection of plants can add a reasonable amount of color to the landscape even at this "quiet" season.

A list of trees and shrubs with colorful fruits in September would be a long one, dominated by members of such rosaceous genera as *Cotoneaster*, *Crataegus*, *Malus* and *Sorbus* but also including species of *Berberis*, *Cornus*, *Euonymus*, *Ilex*, *Magnolia*, *Prinsepia*, *Rhus*, *Viburnum*, and others.

A list of plants with colorful flowers in September is much shorter, and appears below. Careful selection of plants from this list, supplemented with late-flowering herbaceous annuals and perennials, can insure that your garden will remain in bloom in September, as well as in earlier months of summer.

Ornamental Woody Plants Commonly Blooming in September

Scientific Name and Common Name	Tree(T), Shrub(S), or Vine(V)	Hardy in Zone	Flower Color and Usual Time of Bloom in New England
Baccharis halimifolia Groundsel-bush	S	4	Yellowish-white, small. Followed by conspicuous thistle-like fruits on female plants.
Buddleia davidii Orange-eye Butterfly Bush	S	4	White, purple, pink. August to early September.
Clerodendron trichotomum Harlequin Glory-bower	S	6	White (fragrant). Mid-August to mid-September.

Ornamental Woody Plants (*continued*)

Clematis dioscoreifolia robusta (C. paniculata) Sweet Autumn Clematis	V	4	White (fragrant). Late August to mid-September.
Clematis virginiana Virgin's Bower	V	3–4	White, small. Late August to mid-September.
Clematis vitalba Traveler's Joy	V	4	White (somewhat fragrant). Late August to mid-September.
Elsholtzia stauntonii Staunton Elsholtzia	S	4	Light purple, in spikes. Late August to late September.
Franklinia alatamaha Franklinia, Franklin Tree	T–S	5	White, large, yellow stamens. Early September until flowers freeze.
Hydrangea paniculata grandiflora Peegee Hydrangea	S–T	3–4	White, in large clusters, turning pink late.
Hypericum hookerianum Hooker's St. Johnswort	S	6	Golden yellow, large. Early to mid-August, often into September.
Hypericum prolificum Shrubby St. Johnswort	S	4	Bright yellow, small. Late July through August, often into September.
Koelreuteria paniculata 'September' September Golden-rain tree	T	5	Bright yellow, in upright clusters. See *Arnoldia*, volume 27, number 8 (August, 1967).
Lespedeza cyrtobotrya	S	5	Purple, small. August to early September.
Lespedeza japonica Japanese Bush-clover	S	5	White, small. Late September through October.
Lespedeza thunbergii Thunberg Lespedeza	S	5	Red-purple, small. Late August to mid-September.
Potentilla fruticosa varieties and cultivars Shrubby Cinquefoil	S	2–3	Yellow to white. June through August, often into September.
Vitex agnus-castus Chaste-tree	S	6	Pale purple, white, or pink. August to early September.
Vitex negundo incisa Cut-leaved Chaste-tree	S	5	Pale lilac-purple. August to early September.

Harrison L. Flint

MR. VICTOR F. MARX APPOINTED LIBRARIAN OF THE ARNOLD ARBORETUM AND THE GRAY HERBARIUM

Mr. Victor F. Marx was given a joint appointment as Librarian of the Arnold Arboretum and the Gray Herbarium on July 1, 1967. Mr. Marx studied at the College of Horticulture and Viticulture in Budapest, Hungary. He combines horticultural and librarian skills through his B.S.A. and M.S.A. in Agriculture from the University of British Columbia, Vancouver, and his Master of Librarianship from the University of Washington in Seattle.

While pursuing graduate studies, Mr. Marx worked as a laboratory instructor in horticulture and as a research assistant at the Botanical Gardens of the University of British Columbia. Just previous to joining the staff of the Arnold Arboretum he was Instructor of Librarianship and Head of the Acquisitions Department in Bouillon Library of Central Washington State College in Ellensburg, Washington.

Mr. Marx is a member of the American Library Association, Special Libraries Association, American Association of University Professors and Beta Phi Mu, International Library Science Honor Fraternity.

Mr. Marx is married. Mrs. Marx is also a librarian and a graduate of the University of British Columbia School of Librarianship.

GEORGE H. PRIDE APPOINTED ASSOCIATE HORTICULTURIST AT THE ARNOLD ARBORETUM

Mr. George H. Pride was appointed Associate Horticulturist at the Arnold Arboretum effective July 1, 1967. Mr. Pride received both the A.B. degree in Biology and the M.A. degree in Botany from Clark University in Worcester, Massachusetts. He has been an instructor in the Public School System of Worcester from 1937 to 1967, teaching Botany, Zoology and General Biology; Lecturer in Botany in the Evening College of Clark University in 1962; and Botanist at the Worcester Natural History Museum for several years.

Mr. Pride has extensive field experience with both horticultural and purely botanical material. He has collected in the Gaspe Peninsula for the herbarium of Clark University. Part of a collecting trip to Haiti was spent with Dr. Liberty Hyde Bailey. He has explored the countryside of England, Scotland and Wales for both botanical and horticultural material. With Dr. David Potter, formerly of Clark University, he has done an intensive survey of the flora of Central Massachusetts and is now writing a book on the wild flowers of this state.

He is a member of many botanical and horticultural societies. He has served as horticultural show judge, trustee and editor of publications for several of these societies. He is the author of several articles of popular and scientific interest on botanical and horticultural subjects in national and regional publications.

Mr. Pride is active as a hybridizer of iris, lilies and daylilies. He is the recipient of many awards and medals from the Worcester County Horticultural Society and the Massachusetts Horticultural Society for horticultural exhibits during a period of over forty years. He has received the Eugene Parsons Memorial Award for Horticultural Achievement, and the Achievement Medal from the American Hemerocallis Society.

1967 Fall Courses of the Arnold Arboretum

"Walk-Talks" at the Case Estates, Weston **Instructor: Mr. George H. Pride**

A series of walks around the grounds of the Case Estates in Weston with informal discussions of botanical and horticultural points of interest encountered. The objectives are to make one more aware of plants in the fall, to find enjoyment in the diversity of plant material and to understand better what plants are and what they do and, to a certain extent, how they do it. Plant families will be studied informally in their seasonal condition.

Footwear suitable for woodland walking is recommended. Parking is available near the barn at 135 Wellesley Street. All classes start at this location. In case of rain classes will be held indoors at 133 Wellesley Street.

5 sessions, Wednesday afternoons, 2–4, September 27 to October 25.

Registration Fee for Friends of the Arnold Arboretum* – $2.50; $5.00 for others.

Collecting and Treating Seeds of Woody Plants **Instructor: Mr. Alfred J. Fordham**

Do you save seeds to grow your own plants? Mr. Fordham, propagator at the Arboretum, will discuss the methods and problems of collecting and storing seeds and fruits and the methods of pre-treatment to insure proper germination. Wear proper footgear for brief walks around the area near the Dana Greenhouses during part of the time.

1 meeting, Thursday morning, 10–12, September 28. Class limited to 25.

Free; but open only to Friends of the Arnold Arboretum.* Meet at Dana Greenhouses.

Fall Field Course in Ornamental Plants **Instructor: Dr. Donald Wyman**

Informal outdoor talks and field trips on the Arboretum grounds under the supervision of Dr. Wyman and the horticultural staff make up the Fall Field Class. Different plant groups are studied on each trip. The class sessions will consider the berried trees and shrubs, autumn color, the evergreens, and similar topics. Opportunities are afforded for questions and answers relating to the identification and culture of ornamental plants as seen in the Arboretum or as suitable for culture in New England. In case of rain or cold weather, meetings are held indoors.

5 sessions. Friday mornings, 10–12, September 29 to October 27.

Registration Fee for Friends of the Arnold Arboretum* – $2.50; $5.00 for others.

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* Information on how to become a "Friend of the Arnold Arboretum" can be obtained by writing or calling the Arnold Arboretum, Arborway, Jamaica Plain, Mass. 02130.

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A continuation of the
Bulletin of Popular Information
of the Arnold Arboretum, Harvard University

Volume 27 DECEMBER 8, 1967 Numbers 10–11

SEED DISPERSAL BY BIRDS AND ANIMALS IN THE ARNOLD ARBORETUM

IN nature's scheme of things, many remarkable methods have been evolved for dispersal of seeds. Study of these methods is fascinating indeed, and sometimes essential to those involved in collecting seeds for propagation. To understand these methods allows one to collect seeds after they are properly developed for propagational purposes, but before they are lost through natural agencies of dispersal. For the past seven years, notes have been made concerning birds and animals that gather fruits and seeds in the Arnold Arboretum. This has not been a concentrated study, but more a matter of jotting down notes in passing, and it deals only with woody plants.

Although the seeds of some woody plants are dispersed in late spring and throughout the summer, most do not ripen until autumn, rightly considered the time of fulfillment in nature—a season of natural abundance. As ripening occurs, changes come about in the appearance and character of fruits and many plants become dispensers of food. Fleshy fruits containing seeds dependent for dispersal upon animals and birds change to a wide variety of colors attractive to those responsible for their distribution. The pulp furnishes food to the bird or animal, which in turn carries the seeds about in its digestive system until they are ejected in its droppings—and thus are scattered about the countryside. Migratory birds may carry seeds far away from their point of origin.

In late summer, when the nesting season has passed and birds have reared their young, some species congregate in multitudes. These flocks roam the countryside, feeding on fruits and seeds as they ripen. In the Arboretum, trees and shrubs that are heavily laden with fruit can be virtually stripped clean after one visit from such flocks. Removal is often so thorough that large trees bearing countless thousands of fruits one day can be divested by the next—to an extent where it becomes a task to locate one or two fruits.

Fleshy fruits of cherries (*Prunus* species), spicebush (*Lindera benzoin*), viburnums, and the like must often be collected just prior to their final color changes. At this point the seeds will have developed enough to be viable but the fruits will not have reached the stage where they would appeal to their carriers.

Since autumn is a season of plenty, birds can exercise preferences. Some favorites are Asiatic sweetleaf (*Symplocos paniculata*), sassafras (*Sassafras albidum*), dogwoods (*Cornus* species), blueberries (*Vaccinium* species), and magnolias. These plants must be watched closely to collect the fruits before they are taken.

Woody Plants Whose Fruits Have Been Observed Being Taken By Birds and Animals in the Arnold Arboretum

Acer

Red maple (*Acer rubrum*) is ready for natural dispersal about the first week in June. Squirrels and chipmunks have been observed cutting down branch tips bearing fruits and then going to the ground to eat them. Sugar maple (*Acer saccharum*) normally disperses its fruits about mid-September, but in the Arboretum the fruits are taken by squirrels and chipmunks before they can be detached and dispersed by the wind. In one large heavily-laden tree near the Dana Greenhouses, six chipmunks and two squirrels were once seen taking fruits at the same time. In a matter of days, they had removed all of them.

Aesculus

Most horsechestnut and buckeye fruits are ripe about the last week in September at the Arnold Arboretum, and are taken and buried by squirrels—the normal method of dispersal for this group. The squirrels sometimes carry horsechestnuts great distances to soil suitable for easy burying. It is not uncommon to find numbers of horsechestnut seedlings coming up in the Dana Greenhouse nursery, although the closest trees are several hundred yards away.

Amelanchier

Shadblow serviceberry (*Amelanchier canadensis*) ripens toward the end of June and catbirds, robins, one cardinal and chipmunks have been seen taking its fruits.

Betula

Juncos were noted eating birch seeds from the snow along Meadow Road in December, 1963.

Caragana

Caragana seeds ripen in mid-July and dispersal is by propulsion. As the pod dries, tensions are built up in the pod walls. When these tensions become great enough, the pod ruptures and the two halves spring into spirals, hurling the seeds in all directions away from the plant. On hot sunny days, a sharp snapping sound can be heard—this announces that the seed must be harvested promptly before it is lost. At this time, pigeons and robins search the ground for seeds that have been shed.

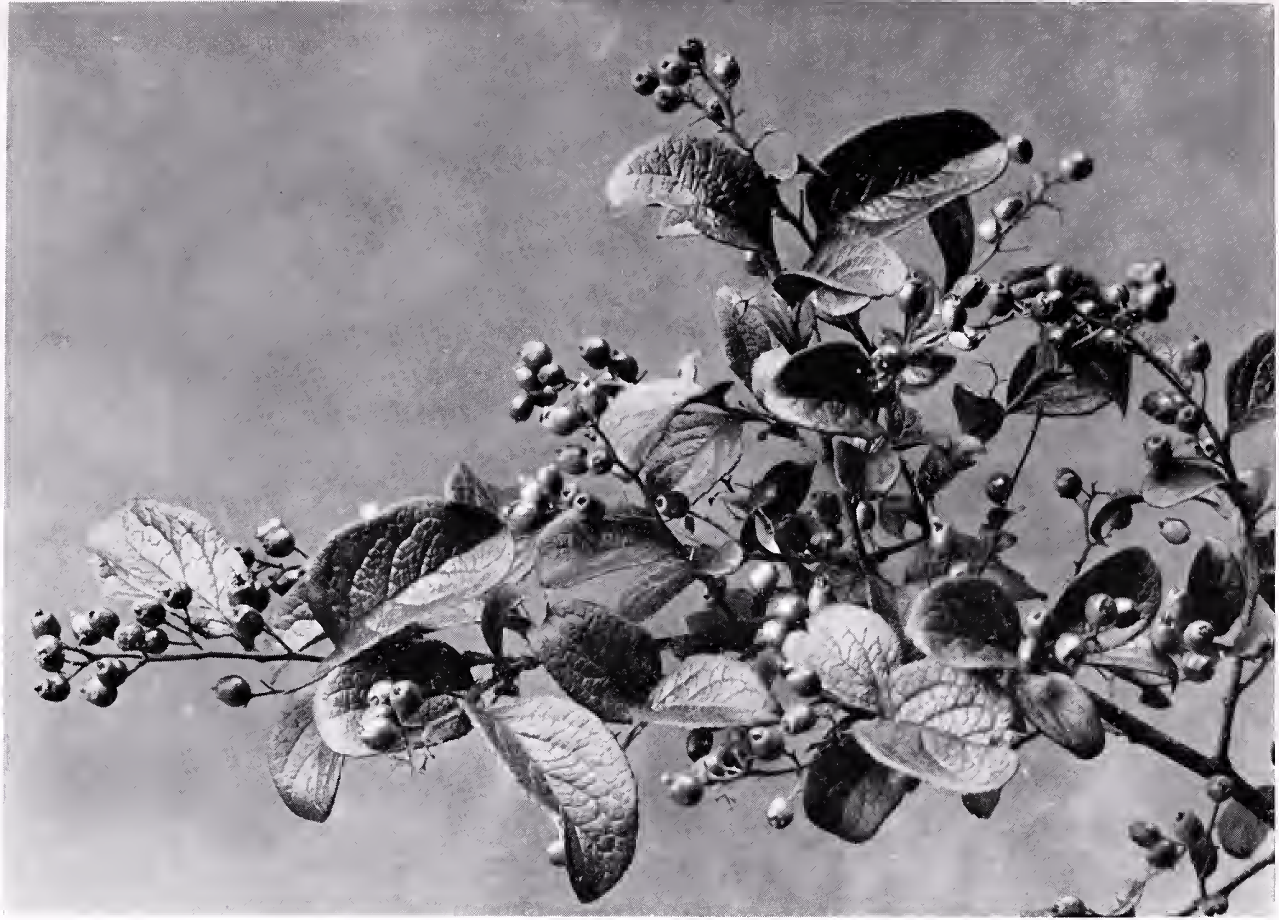

PLATE XXI

The bright blue fruits of Asiatic sweetleaf (*Symplocos paniculata*) are quickly taken by birds in the Arnold Arboretum.

Chaenomeles

In the Arnold Arboretum, rats have been seen biting through flowering quince fruits to get the large number of seeds they contain.

Chamaecyparis

In mid-January, 1965, chickadees and siskins were seen feeding from false-cypress cones while one over-wintering towhee was on the ground, apparently feeding on seeds that had fallen.

Chionanthus

Chinese fringetree (*Chionanthus retusus*) is ready for collection about the first of October, and robins, starlings and pigeons have been recorded as eating the fruits.

Cornus

Many species of dogwood are favorites of birds. Fruits of a number of species ripen erratically and birds make daily visitations to collect those that are prime. Giant dogwood (*Cornus controversa*) has been noted as bearing ripe fruits from August 8 through September 7, while Korean dogwood (*Cornus coreana*) ripens erratically from August through October. Robins, starlings, catbirds, and grackles have been observed taking these fruits. Flowering dogwood (*Cornus florida*) is a great favorite—it ripens about mid-September and disappears quickly. In 1964, a prolific year for this species, all the fruits had been taken by October 1. Robins, grackles, starlings, and catbirds, together with chipmunks, have been listed as taking flowering dogwood fruits. Japanese dogwood (*Cornus kousa*) is of interest for it appears to be ignored by the birds. Chipmunks, however, remove the seeds from the large strawberry-like fruits and leave the plants with their cheek pouches bulging. This defeats natural dispersal, for chipmunks store the seeds in their larders where there is no possible chance for reproduction. Japanese dogwood in its native habitat must have some other carrier, possibly a large animal such as a deer, that takes these fruits and distributes the seeds as nature intended.

Cotoneaster

Some years ago, during the height of the parakeet craze, many escaped from captivity and some came to the Arnold Arboretum. The cotoneasters attracted these birds in autumn, and sometimes several would be seen at a time, slitting open the fruits and crushing the hard seeds with their powerful beaks. Parakeets are gregarious birds and it is interesting that they were frequently seen flying with starlings. One for some odd reason became lead bird for a starling flock. He perhaps was more properly attired for this position than were his hosts. Chipmunks also work the cotoneasters and this year took all the fruits from four plants in front of the Dana Greenhouses, starting in early July when the fruits were green and undeveloped and a cut test showed the seed contents to be small and milky.

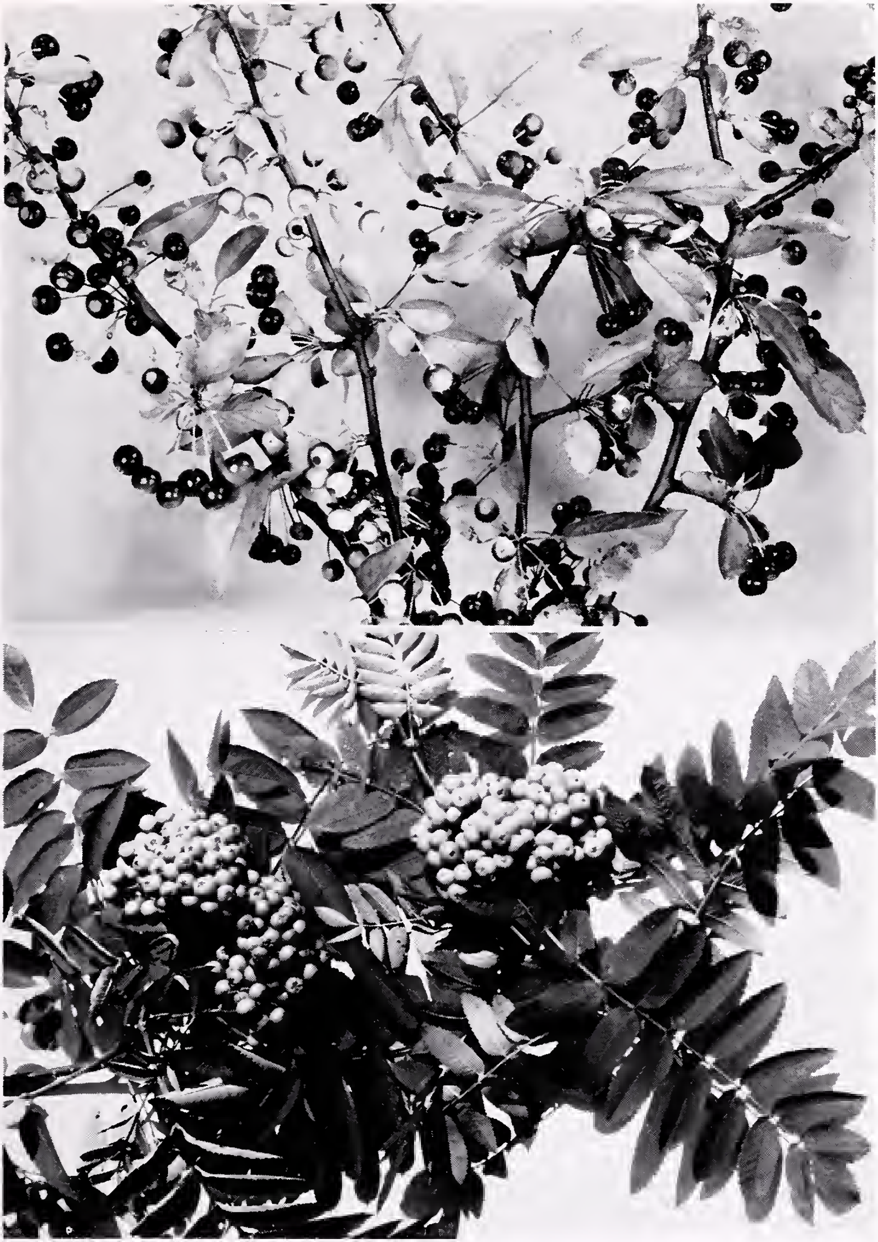

PLATE XXII

Two genera that supply large quantities of bird food are *Malus* and *Sorbus.* (Top) *Malus sargentii,* the Sargent crabapple. (Bottom) *Sorbus aucuparia,* the European mountain-ash.

Ehretia

Heliotrope ehretia (*Ehretia thyrsiflora*) fruits ripen erratically through the month of September and birds visit regularly to take those that are ready. Chickadees, house sparrows, and one unidentified sparrow have taken its fruits.

Elaeagnus

Cherry elaeagnus (*Elaeagnus multiflora*) is recorded as ripening erratically through the month of July, with starlings taking its fruits. Autumn elaeagnus (*Elaeagnus umbellata*) ripens from September 1 through early October. It is taken by starlings, robins, and catbirds.

Evodia

The shiny black seeds of evodia are ready for collection in late September, and starlings come to feed when the capsules open.

Fraxinus

The fruits of American ash (*Fraxinus americana*) remain fixed to the trees through the winter. Red-winged blackbirds have been recorded as taking the fruits in late October, and chickadees have been seen feeding on them during the winter.

Gleditsia

During the winter, crows perch in honeylocust trees (*Gleditsia triacanthos*) and pull off the pods. Then holding them between their feet, they tear them apart and eat the seeds. The usual method of dispersal is by wind. The pods, which are firmly affixed to the tree, are torn off by high winds during winter and carried some distance away. Sometimes they can be seen being propelled by wind over frozen snow and can be found lodged against obstacles some distance from the parent plant.

Kalopanax

Castor aralia (*Kalopanax pictus*) produces heavy crops of fruits in alternate years in the Arnold Arboretum. Its fruits do not ripen at once and birds make daily visits to collect those that are prime. Starlings, robins, and pigeons come to feed when the fruits are ready. This tree is a favorite with pigeons and they seek out the six trees located in different parts of the Arboretum. In season, they can be found on these trees every day.

Ligustrum

Only pigeons and starlings have been observed collecting privet fruits, which are ripe about mid-October.

Lonicera

Most honeysuckles have wide latitude in ripening time. Some berries will be prime while others are still green. Fruits are taken by robins, starlings and pigeons. Pigeons sometimes descend on these plants in such numbers that the branches are bent to the ground by their weight.

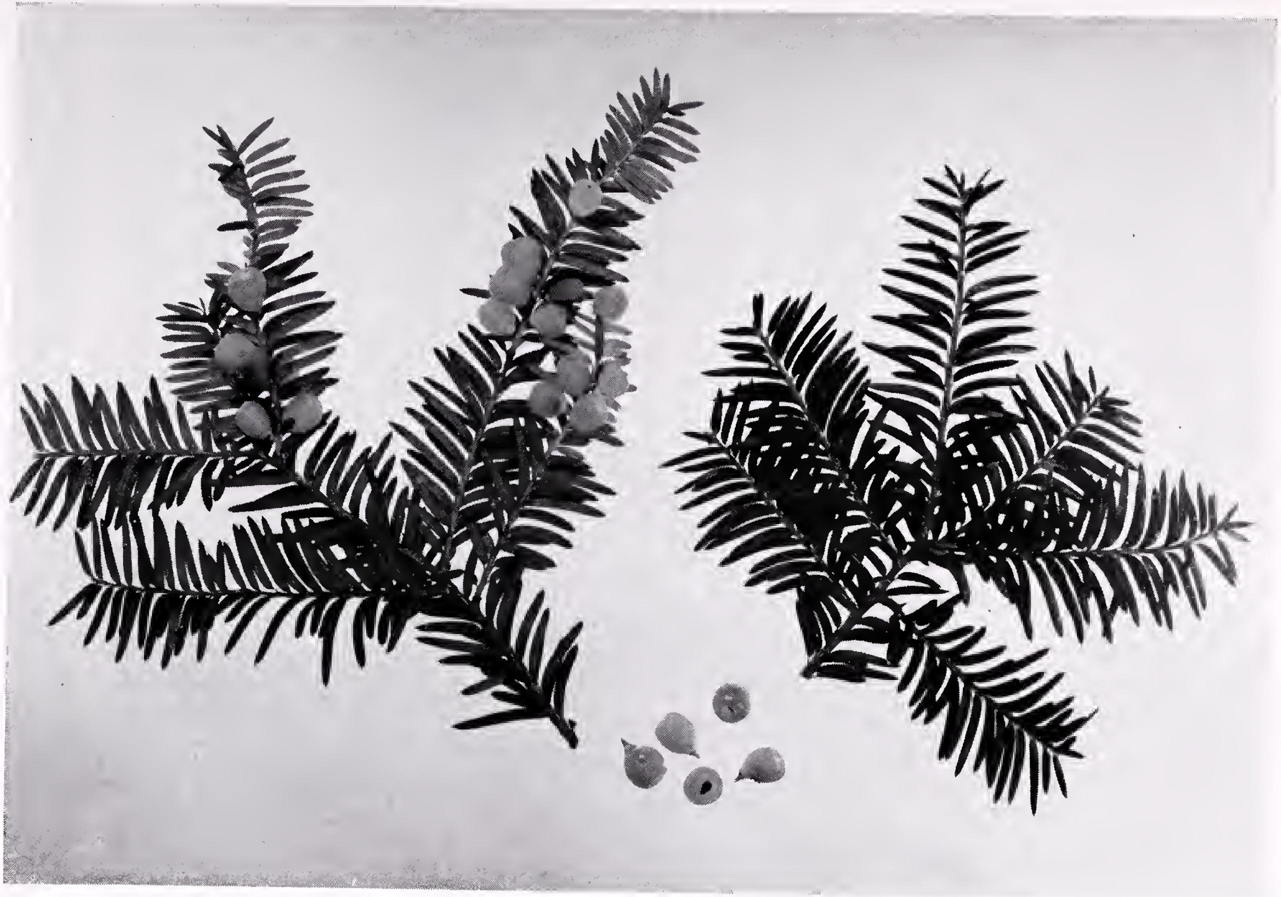

PLATE XXIII

The ripening of yew fruits in October brings on a host of birds, including starlings, cedar waxwings, robins and bluejays. The Japanese yew (*Taxus cuspidata*) is shown.

Lonicera quinquelocularis transluscens produces whitish translucent fruits which remain on the plant into winter. Its berries are not taken by birds, no doubt because they lack attractive color.

Magnolia

Magnolia seeds, another favorite of the birds, ripen and are ready for collection about mid-September. Dispersal of these seeds is most interesting. They are contained in chambers within colorful cones. At ripening, the chambers open and the seeds emerge and dangle on slender cords called suspensors. In this way they are available to birds while still on the tree, and have been seen being taken by robins and starlings. Those that fall from the trees are eaten by rodents, and dispersal is thereby defeated. Squirrels have also been seen taking these seeds.

Malus

The crabapple collection in the Arnold Arboretum unquestionably provides more food for birds, over a longer period of time, than any other genus. This extensive collection includes 96 species and 191 cultivars. Fruits of some crabapples are soft and ready to be taken by birds in mid-September, e.g. tea crabapples (*Malus hupehensis*), midget crabapple (*M. micromalus*) and Sargent crabapple (*M. sargentii*). Others go on into winter in a firm condition and are not soft enough until they have been frozen. Still others for some reason pass through the winter and spring without being taken, and remain on the trees as mummified fruits after the new leaves have unfurled. Those that are ready in autumn have been taken by cedar waxwings, cowbirds, robins, flickers, bluejays, and starlings. Starling flocks sometimes have comprised hundreds of birds. The chipmunks that have inhabited the Arboretum in ever-increasing numbers during the past few years also work the autumn crabapples.

During the cold winter months, when snow covers the ground and there is a dearth of food for birds, the crabapple collection really comes to the fore. Flocks of robins, sometimes comprising 40 or 50 birds, are not an uncommon sight in the crabapple collection during winter. Some authorities have suggested that these robins nest further north and have migrated only this far south for the winter. Large flocks of cedar waxwings also take advantage of the winter crabapples. Other birds noted in winter are starlings and purple finches, and in years when evening and pine grosbeaks invade the region they can be found in the Arboretum's crabapple collection.

Many winter birds peck through the pulp of crabapples and eat the seeds. In the process, the pulp falls to the ground and is eaten by pigeons, pheasants and rabbits.

Morus

Birds are very fond of mulberries, which ripen about mid-June. Our records show that thrashers, catbirds, robins, and rosebreasted grosbeaks have eaten mulberries.

PLATE XXIV

Viburnum fruits ripen erratically and birds make daily visits to those that are prime. (Top) Fruits of Siebold viburnum (*V. sieboldii*) turn from red to black as they ripen in late August, and are taken quickly when this color change occurs. (Bottom) Withe-rod (*V. cassinoides*) fruits pass through several colors during ripening: green, yellowish, reddish, and blue-black. They are taken at the last color stage.

Nyssa

Black tupelo (*Nyssa sylvatica*) is the only tupelo hardy in the Arnold Arboretum. Plants of this species are usually dioecious, and fruiting trees bear heavy crops each year. These blue-black fruits are a favorite of the birds, and when they are prime the fact is announced by the chattering of robins, starlings, catbirds, bluejays and waxwings, as they completely strip large trees in a few days. Squirrels and chipmunks also take black tupelo fruits.

Parthenocissus

Boston ivy (*Parthenocissus tricuspidata*) fruits well each year and its berries are ripe about mid-October. Starlings and robins have been noted eating its fruits.

Phellodendron

Starlings and robins have been seen taking the fruits of cork trees. In the last few years, the fruits of all but the Chinese cork tree (*Phellodendron chinense*) have been gone long before winter. This species, however, retains its firm fruits into mid-winter. During this time starlings and crows perch on its branches to feed.

In 1964 a pair of mourning doves was seen feeding beneath a Chinese corktree in the Arboretum from early March on into mid-May. During the early part of this period snow would sometimes fall and cover the ground. However, each time the snow melted the pair would return.

Some years ago a large volunteer corktree appeared in a patch of natural woods at the Arboretum. It fruited well, and during the winter furnished a continuous food supply to a solitary mockingbird. In late February, an exceptionally large flock of roving cedar waxwings found the tree and spent several days devouring its fruits. The unfortunate mockingbird, its source of food eliminated, disappeared.

Prunus

The cherries are favored by many kinds of birds, but our records only show those seen working Sargent cherry (*Prunus sargentii*). Catbirds, starlings, robins, cedar waxwings, and pigeons descend in numbers when its fruits are ripe. Chipmunks have also been seen leaving these trees with cheek pouches filled.

Pyracantha

Firethorn fruits ripen in early September and its fruits have been taken by robins, starlings and chipmunks.

Chipmunks, in removing fruits from the espaliered plants on the Dana Greenhouse cold storage building, do so in a systematic manner. They start at the bottom of a branch and progress upward leaving the sections where they have worked completely barren.

Quercus

Bluejays are the only birds seen taking acorns. Squirrels and chipmunks, however, are busy in the oak collection during September and October and frequently collect acorns before they have developed enough for propagation purposes.

Rhamnus

Robins, starlings, and pigeons have been seen taking buckthorn fruits in the Arnold Arboretum.

Rhus

Our only observation concerning *Rhus* is that of a flicker eating berries of poison ivy (*R. radicans*).

Sambucus

We have no record of which birds take our elderberries, but we do know that they disappear immediately when ripe. Along route US 1 in Westwood, Massachusetts, hundreds of starlings were seen for several days eating fruits from an extensive mass of American elderberry plants (*S. canadensis*).

Sassafras

Sassafras (*Sassafras albidum*) is another favorite of birds, and it is difficult to collect ripe seeds before they are taken. The fruits are borne on bright red stalks resembling golf tees. We lack records of which particular birds take them, but a check of this species at the Arboretum and in natural woods has shown that the fruits have all disappeared by mid-September, leaving only the colorful red stalks.

Sophora

Japanese pagoda tree (*Sophora japonica*) flowers late, its fruits develop late, and its pods remain on the trees into winter, when squirrels and starlings have been seen eating the seeds.

Sorbus

Large flocks of starlings and robins descend on the mountain ash trees in early autumn and the ripe fruits quickly disappear.

Symplocos

Asiatic sweetleaf (*Symplocos paniculata*) with its beautiful display of intense blue fruits is another favorite of birds, including starlings, robins, and catbirds. Its fruits ripen about mid-September and can disappear in a day in the Arboretum, so when seeds are needed for propagation the seeds must be gathered before they are fully ripe

Taxus

In mid-October when yew (*Taxus* species) fruits are ripe, a host of birds appear. Our records show that starlings, cedar waxwings, robins, and bluejays, as well as squirrels, come to feed.

Tsuga

About mid-October when the cones of Canada hemlock (*T. canadensis*) open to release their seeds, many birds come to feed. Those noted in the Arboretum are juncos, goldfinches, white throated sparrows, bluejays, chickadees and siskins.

Vaccinium

Many species of birds and animals are fond of blueberries. During a recent visit to the home of Prof. Elwin M. Meader, formerly of the University of New Hampshire, I remarked on the variety of birds invading his commercial blueberry planting. His comment was: "The only things that don't eat blueberries are fish, and the only reason they don't is that they can't get at them." In the Arnold Arboretum, robins, flickers, starlings, bluejays, chickadees, towees, cedar waxwings and thrashers have eaten blueberries.

Viburnum

Many *Viburnum* species produce fruits that ripen erratically over a span of time and birds make daily visitations to take those that are ready. Seeds of these species must be collected before they are fully ripe. Catbirds, robins, starlings, thrashers, chipmunks, and squirrels have been noted taking fruits of *Viburnum* species.

Fruits of Sargent cranberrybush (*Viburnum sargentii*) have a disagreeable odor and perhaps are distasteful, for they are usually ignored by birds. Pheasants, however, have been seen feeding on them in mid-winter, perhaps in desperation.

The Arnold Arboretum as a Sanctuary

The Arnold Arboretum provides a sanctuary for birds and other small wildlife —it is a garden of fruit-producing woody plants surrounded by a highly urbanized area. Birds that come in autumn find few enemies and stay to feed on the continuing progression of ripening fruits. They move about the grounds devouring all that is edible. The starling, an introduced alien, is the most abundant bird found in the Arboretum, as evidenced by its frequent appearance in the above list. It collects in large flocks whose numbers far surpass those of all other birds combined, presenting a serious problem in the Arboretum. Starlings are largely responsible for disappearance of ornamental fruits before they can be enjoyed by visitors or collected for propagation or distribution to other institutions. The vast population of chipmunks and squirrels are also a nuisance, for they often take fruits before the seeds are developed enough for propagation.

It is interesting that in the suburbs such plants as mountain-ash and pyracantha often hang heavy with fruit into winter, while these plants in the Arboretum are usually stripped by October. During a recent field trip to Long Island (October 11–14), countless flowering dogwoods (*Cornus florida*) were seen bearing crops of untouched fruits while this year's crop at the Arboretum was gone by mid-September. Plants of Asiatic Sweetleaf (*Symplocos paniculata*) were seen hanging heavily with soft ripe fruits—a condition never seen in the Arboretum, for here these are taken by birds before they ripen fully.

Alfred J. Fordham

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BOTANICAL GARDEN

A continuation of the
Bulletin of Popular Information
of the Arnold Arboretum, Harvard University

Volume 27 DECEMBER 29, 1967 Number 12

ROOTING OF CONIFER CUTTINGS[1]

(Seedage is the most common means of propagating most conifer species, but when cultivars or forms of distinct character are to be propagated, vegetative means usually must be resorted to. Propagation by cuttings has been highly successful in some cases. In others, propagators have had to resort to the more difficult and costly process of grafting in order to insure success. The study described here was an attempt to gain fuller understanding of the environmental requirements for successful cutting propagation of several conifer species and cultivars, selected to represent both easy- and difficult-to-root types. This study constituted a part of the graduate study requirements of the senior author.[2] The following is an edited translation by the same authors of their article "Einfluss der Jahreszeit auf die Stecklingsvermehrung von Koniferen" which appeared in the German horticultural journal GARTENWELT, Vol. 67, No. 15, pp. 309–311, 1967.
—EDITOR.)

Procedures

Cuttings of ten different conifers (see Table I) were taken at approximately bimonthly intervals: in December, February, April, June, August, and October. The same stock plants were used throughout in order to eliminate genetic variations. In most cases a single stock plant provided all the cutting material. (The ages of the stock plants were not specifically discussed in this article. As a matter of interest, all stock plants were at least 15 years of age except those of *Juniperus horizontalis* 'Glomerata' which were between 5 and 10 years old. Those of *Abies concolor*, *Juniperus virginiana*, and *Tsuga canadensis* were at least 25 years old.—EDITOR.) Cuttings were treated with the rooting hormone indolebutyric acid (IBA) in talc at 4 different concentrations. A fungicide (Captan 50W) had been added to the preparation. Then the cuttings were inserted in a greenhouse bench in a mixture of equal parts by volume of coarse perlite and peat moss. Thermostatically controlled heating cables kept the temperature of the rooting medium at about 68° F. for half of the cuttings, and at about 79° F. for the other half. Each rooting temperature was replicated 4 times in the greenhouse bench, to allow proper statistical treatment of the results. At each sampling date, 40 cuttings of each species or cultivar were made and assigned to each treatment combination (temperature–IBA concentration). Thus the study involved a total of 1280 cuttings of each conifer.

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[1] Vermont Agricultural Experiment Station Journal Series Paper No. 194.

[2] Jesinger, Rolf. The influence of various treatments on the rooting of cuttings of certain conifers throughout the year. M.S. Thesis, University of Vermont, Burlington, Vermont. 1967.

The air temperature in the greenhouse during the day normally reached about 73° F., but during the summer months occasionally went as high as 86° F., even with the use of an evaporative air-cooling system. Intermittent mist was regulated by a Mist-A-Matic controller. This device controls mist applications in relation to rate of evaporation of water from a counterbalanced screen in the misted area.

The time required for root formation is known to vary among different species of conifers. In this study, the time needed for cuttings taken in December to root was compared. The times required for at least 50% of the cuttings of the following 5 conifers to show root formation were:

Thuja occidentalis 'Globosa'	8 weeks
Juniperus chinensis 'Pfitzeriana'	11 weeks
Juniperus horizontalis 'Glomerata'	11 weeks
Juniperus chinensis 'Hetzii'	12 weeks
Abies concolor	13 weeks

Cuttings of *Picea glauca* 'Conica' were removed after 13 weeks, *Pinus mugo* after 14 weeks, and *Tsuga canadensis* after 18 weeks. Only a small percentage of the cuttings of these 3 species showed roots, but it appeared that no further root formation could be expected. *Picea pungens glauca* and *Juniperus virginiana* were always left in the cutting bench for 15 weeks but showed relatively little rooting throughout the year.

Results

The time of year when cuttings were taken, the temperature of the rooting medium, and hormone concentration played differential roles in the rooting of cuttings of the various conifer species. Time of year was the single most important factor.

All cuttings of *Juniperus chinensis* 'Hetzii' rooted when taken in June. Good rooting was also obtained at both rooting temperatures on cuttings taken in April, August, and October. Similarly, cuttings of *Juniperus horizontalis* 'Glomerata' rooted best in June, August, and October. With both of these junipers, rooting of cuttings taken in the remaining months was improved at the higher temperature of the rooting medium.

Juniperus chinensis 'Pfitzeriana' averaged nearly 90% rooting in April, while

TABLE I

OPTIMUM TREATMENTS FOR ROOTING CUTTINGS OF TEN CONIFERS

(Arranged According to Ease of Rooting)

	Conditions of best treatments			Percentage rooting	
	Month of propagation	Temperature of rooting medium (°F)	IBA concentration (% in talc)	Best treatment	All treatments
Juniperus chinensis 'Hetzii'	June	68	0.3	100.0	87.8
Juniperus horizontalis 'Glomerata'	April	79	0.3	100.0	81.4
	August	79	0.3		
	August	79	0.8		
	October	68	0.3		
Thuja occidentalis 'Globosa'	December	79	1.5	97.5	75.8
	April	68	2.0		
	April	79	0.3		
	April	79	1.5		
Juniperus chinensis 'Pfitzeriana'	April	79	0.3	95.0	68.2
Picea glauca 'Conica'	April	79	1.5	90.0	26.6
Tsuga canadensis	February	68	0.3	70.0	27.4
Abies concolor	December	68	2.0	57.5	30.2
Pinus mugo	June	68	0.3	42.5	18.0
Juniperus virginiana	October	79	0.8	30.0	6.0
Picea pungens glauca	October	79	0.8	15.0	2.8

the most successful treatment resulted in 70% to 80% rooting at other times of the year. As with the previously described junipers, the higher temperature of the rooting medium gave better results than the lower. Higher IBA concentrations, in general, increased rooting at the lower temperature.

Picea glauca 'Conica', too, in several cases rooted better at the higher temperature. However, only cuttings taken in April gave rooting percentages as high as 80% to 90%. Propagation at other times of the year did not appear to be economical.

Thuja occidentalis 'Globosa' rooted successfully throughout the year, with a peak of almost 100% rooting in April. Surprisingly, under our conditions rooting was suppressed when the cuttings were taken in October. This might have been overcome had the cuttings been left a longer time in the propagating bench. The higher rooting temperature almost doubled the rooting percentages over those for the lower temperature in October.

In contrast to the previously described conifer species, best results with *Tsuga canadensis* and *Abies concolor* were obtained when the temperature of the rooting medium was kept at 68° F. Rooting as high as 70% occurred on *Tsuga canadensis* in February and at a slightly lower percentage in April, with the 2.0% hormone concentration. *Abies concolor* is generally propagated by seed, but there is great interest in vegetative propagation of individual plants that are especially desirable because of color or growth habit. They could be propagated by grafting, but cuttings would be preferable if a rooting percentage of at least 50% could be obtained, In this study, this percentage was reached or surpassed in December, February, and October.

Pinus mugo generally showed only small rooting percentages. Relatively good results were obtained when new shoot tips were used as propagating material in June.

Detailed results for 3 of these species are shown in Plate XXV.

Discussion

This brief description of our results indicates that these conifers can be propagated successfully by cuttings at one time of the year or another. The best results varied not only with the time of year but also with the temperature of the rooting medium. Increasing the IBA concentration above 0.8% in most cases did not result in greater rooting.

The maximum rooting percentage for each species, together with the conditions under which it was obtained, is shown in Table I. For comparison, the average rooting percentage for each species is included in the table, considering all treatments and all times of the year.

So far, we have limited our discussion to rooting percentages but, in general, the higher rooting percentages were accompanied by more and larger roots per cutting.

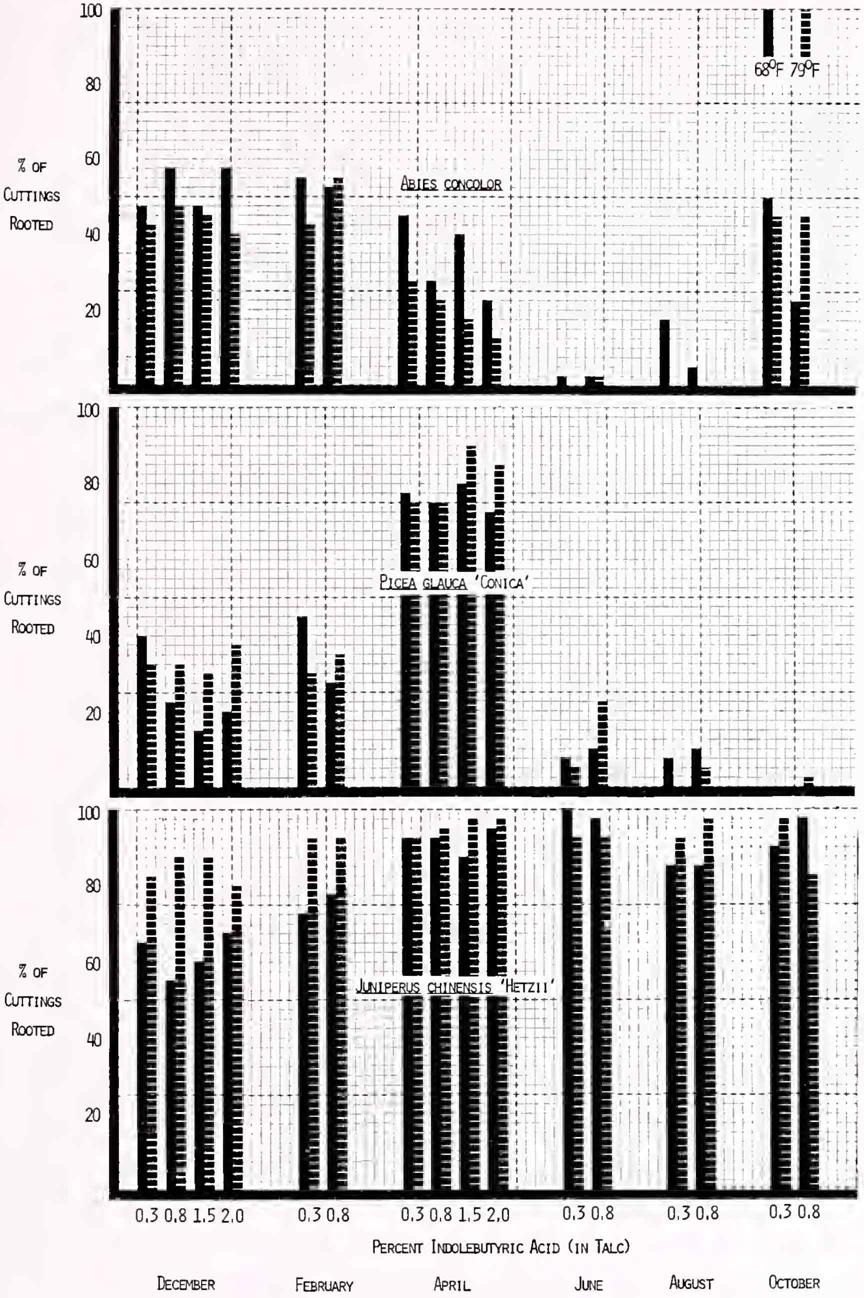

PLATE XXV

Effect of time of year, temperature of the rooting medium, and concentration of indolebutyric acid (IBA) on rooting of cuttings of three conifers.

Additional factors, of course, affect the rooting of cuttings to varying degrees. Nutritional status of the stock plant, rest period, juvenility, and environmental factors all play important parts. These factors were not specifically included in this study.

(NOTE: For the benefit of the European reader, the German article concluded with a discussion of the geographical location, temperature, and light conditions of Burlington, Vermont, where the investigation was carried out, as compared with Hamburg, Germany.)

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ARNOLDIA REVIEWS

Allen, Mea, *The Hookers of Kew, 1785–1911*, Michael Joseph Ltd., London, 1967, 273 pp.

It was high time that someone wrote a good popular biography of Kew's illustrious Hookers, and Mea Allen has done it. Quite possibly some potential biographers were scared off by Leonard Huxley's excellent *Life and Letters of Sir J. D. Hooker*, for the younger Hooker was a gifted correspondent, and the record of his writings was complete enough to compose — mostly in his own words — what is still the liveliest and best account of his life. W. B. Turrill's 1963 effort on Sir Joseph's behalf was, to say the least, a disappointment. Meanwhile, the elder Hooker, Sir William Jackson, has been comparatively neglected and treated offhandedly as the famous father of a more famous son.

Miss Allen decided to handle both Hookers, as a team, in one volume. Considering the size and scope of their achievements she has done a remarkable job, for there are chapters in her biography that could justifiably be expanded to entire books. Because her control over the material and subject matter is judicious, she creates a well-balanced, fast-moving, and often entertaining personal history. Sir William obviously presented the author with research problems. She has painstakingly investigated obscure sources to piece together the story of his youth: from the time he collected a rare little moss through his association with Dawson Turner (his future father-in-law), his introduction to Sir Joseph Banks, his voyage to Iceland, his years as a teacher at Glasgow, his arrival at Kew, and his subsequent efforts to build that institution into one of the greatest botanical gardens of all times. There are moments when one wishes that Miss Allen either could or would indulge us with greater detail, but that might upset the balance of things.

Joseph, devoted to his father, followed in his footsteps and surpassed his achievements as a scientist. No one can describe his voyage to the Antarctic with the Ross expedition or his adventures in the Himalayas better than he did himself in letters and journals, but Miss Allen has done well with shorter accounts, for she has a gift of selecting the right amount of detail to keep the story alive even though it is abbreviated. Hooker's friendship with Darwin, his involvement with the *Origin of Species*, his desperate battles with the Government to save Kew, are also told this way. Personal and family matters run through the narrative, and the association between father and son is in constant focus even when Sir William is but a ghost.

If there is a negative criticism to be made it is that, since the Hooker family was a large one, nieces, nephews and various in-laws keep cropping up in the text and the reader is hard put to identify them. Miss Allen tried to remedy the problem by supplying a genealogical chart in the back, but in so short a book some of the lesser characters could be omitted. The author did a great deal of scholarly research, and the more serious readers may wish that she had given a complete set of references for their use. But the casual reader, for whom the book was evidently written, will probably not miss them.

The Hookers of Kew is an excellent brief account of the long, productive lives of two of England's greatest botanists. Lovers of Kew, science, history, and exploration should welcome and enjoy it.

S. S.

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